SCIENCE ABSTRACTS.

PHYSICS AND ELECTRICAL ENGINEERING.

OCTOBER 1901.

GENERAL PHYSICS.

1852. *Maximum Density of Aqueous Solutions.* **L. C. de Coppet.** (Comptes Rendus, 132. pp. 1218–1220, May 20, 1901.)—This is a study of the molecular lowering of the temperature of maximum density of water produced by the solution of chlorides, bromides, and iodides of potassium, sodium, rubidium, lithium, and ammonium ; and of the relations of these lowerings among themselves. In accordance with the law of Despretz, the lowering of the temperature of maximum density is proportional to the quantity of substance dissolved. The molecular lowering is very nearly constant, except in the case of lithium, where the molecular lowering increases with the concentration.

The following table gives the mean molecular lowerings :—

	Chloride.	Bromide.	Iodide.
Rubidium	11·7°	13·2°	15·6°.
Potassium	11·6	12·8	15·4
Sodium	13·2	14·5	17
Lithium	6·0	7·0	8·3
Ammonium	7·2	8·7	11·1

The ratio between the lowerings produced by the chloride and the bromide respectively is nearly the same for every metal of the same group. E. E. F.

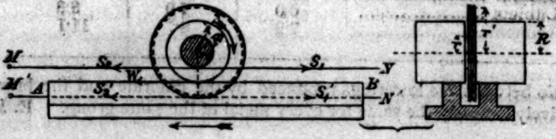
1853. *Density of Ice.* **H. T. Barnes.** (Phys. Rev. 13. pp. 55–59, July, 1901.)—In a paper in the Phys. Rev. in 1899 [Abstract No. 397 (1899)], Professor Nichols found a difference of 2 parts in 1,000 between old and new ice. This paper gives a description of taking the density of ice by weighing it in ice-cold water with suitable precautions, and the author finds that the density of old and new river ice is the same, and may be taken as 0·91661 ± 0·00007, which agrees within 2 parts in 10,000 with that given by Nicholson for natural river ice not newly cut, which is 0·91644, and, to the same order of accuracy, with the measurements of Bunsen. E. C. R.

1854. *Vibrations of Liquid Surfaces of Determinate Shapes.* **C. Chéneveau and G. Cartaud.** (Comptes Rendus, 133. pp. 273–276, July 29, 1901.)—A short paper on the figures of ripples produced on the surface of mercury contained in dishes of different shapes under the influence of vibration. Illustrations are given for the cases of rectangular or square dishes, and of circular dishes. The nature and inclination of the walls have no effect on the form of the ripples. Grains of lycopodium, or light floats, thrown on the vibrating surface, describe closed paths whose number and shape vary with the profile of the dish and the method of vibration. W. C. H.

1855. *Polish.* **Rayleigh.** (Nature, 64. pp. 385–388, Aug. 15, 1901. Paper read before the Royal Institution, March 29.)—A lecture, with experiments, on the nature of the process known as "polishing." With finely ground, as distinguished from polished, glass surfaces, it is possible to obtain such a fineness that a candle is seen reflected at an angle of incidence not exceeding 60°, measured from the perpendicular; but these surfaces are still too coarse for perpendicular specular reflection of the longest visible waves of light, although from experiment it seems certain that they are fine enough to reflect without sensible diffusion the longest waves, such as those found by Rubens to be nearly one hundred times longer than the waves of red light. From these phenomena it might be inferred that grinding and polishing are essentially alike, but the balance of evidence appears to point in the opposite direction. While in grinding the action of the powder is by pitting the surface, breaking out small fragments, in polishing the operation is in all probability a molecular one, no coherent fragments containing a large number of molecules being broken out.

The author has made experiments to find how much material is removed during the polishing of glass. In one case a thickness of about six wavelengths of mean light was removed during the process; in another case, with very finely ground surfaces, polish was effected during a lowering of the mean surface through two or three wave-lengths. Other experiments dealing with the action of hydrofluoric acid are described. W. C. H.

1856. *Experiment in Dynamics.* **V. v. Niesiolowski-Gawin.** (Ann. d. Physik, 5. 2. pp. 479–482, May 29, 1901.)—The author describes a modification of Kommerell's apparatus for producing a downward motion on an inclined plane by an upward pull. A roller is mounted on a couple of rails, and provided with two pulleys of radii r and r'. A string is wound round either of the pulleys, and held taut by the hand at N or N′. The rail is displaced along its own length, and the roller goes with or against it in accordance with the pulley used. The rolling surface must not allow of sliding. E. E. F.



1857. *Surface Tension of Oil Films on Water.* **R. H. Weber.** (Ann. d. Physik, 4. 4. pp. 706–721, April, 1901.)—When olive oil is dropped on water, a film is formed in the middle of which an oil drop persists. The experiments show that the size of this drop, its angle of contact, and the surface tension of the film, vary with the size of the surface. The values of surface tension found varied also with time, and it was concluded that the film consisted of a third liquid formed from the oil and water, probably by hydrolysis. The surface tension of the film may assume values much smaller than the theoretical one, viz., 5·4 mg./mm. G. E. A.

1858. *Influence of Pressure on the Viscosity of Water.* **L. Hauser.** (Ann. d. Physik, 5. 3. pp. 597–632, June, 1901.)—The influence of pressure up to 500 atmospheres in the temperature range of 15°–100° was studied. The capillary tube method was employed. The paper contains an elaborate account of the apparatus and methods employed. The chief results are as follows :—

(1) Up to 32° increase of pressure diminishes the viscosity.

(2) In this temperature region the effect of pressure diminishes with increasing temperature.

(3) In the neighbourhood of 32° increase of pressure up to 400 atmospheres has no effect on the viscosity-coefficient.

(4) Above 32° the viscosity is increased by an increase of pressure of 400 atmospheres. F. G. D.

1859. *Rotary Comparator.* **J. Pernet.** (Archives Néerlandaises, 5. pp. 395–406, 1900.)—The form of transverse comparator which is least subject to errors produced by bending is that of Wild, in which the rods to be compared are mounted in a frame in a vertical plane and are lifted vertically into sight. This form of comparator fails when the rods are to be immersed in liquids. The author constructs a rotary comparator which admits of exchange with extreme smoothness and simplicity. A stout cylinder rotates about its own axis, which is placed vertically. The cylinder carries a table in form of a lemniscate, on each of the leaves of which one of the rods is mounted, and supported at ¼ and ¾ of its length. The author gives full details of construction. E. E. F.

1860. *Contact Deformation of Elastic Bodies.* **A. Lafay.** (Annal. Chim. Phys. 23. pp. 241–288, June, 1901.)—This paper contains the full description and discussion of the author's experiments, concerning which a preliminary note has already been published [see Abstract No. 4 (1901)]. The deformations of two spheres of steel or of bronze when in contact with one another under different pressures, and the deformations when a sphere is in contact with a plane surface, are fully examined, and the results compared with those given by Hertz's mathematical analysis of the problem. The author finds that Hertz's formulæ only imperfectly represent the real phenomena. In particular, Hertz's conclusion that the diminution of distance between centres of two bodies under pressure p varies as $p^{\frac{2}{3}}$ is only true where the deformations of the bodies are relatively large. The divergence from theory becomes greater as the deformations become less, and this is all the more singular in that the theory is based on conditions of small deformation. Friction between the two deformed bodies appears, on experiment, to be insufficient to account for this singularity. W. C. H.

1861. *Permanent Deformations.* **H. Bouasse.** (Annal. Chim. Phys. 23. pp. 193–240, June, 1901.)—A searching criticism of Coulomb's theory (Savants étrangers, 1773) as developed by Dugnet (*Limite d'Élasticité et résistance à la* *rupture*, 1885) and others. The conclusion is that the theory is in a rudimentary state; that it does not enable any of the peculiarities of the actual phenomena to be worked out, nor any precise comparison to be made with experiment. In many respects in the form adopted by engineers it contradicts established facts and the principles of Mechanics. An appendix is given as to the action and theory of a draw-plate. A. D.

1862. *Natural Laws.* **H. Pellat.** (Journ. de Physique, 10. pp. 277–279, 1901.)—Referring to the law of dissipation of energy, the author endeavours to trace the consequences of this in past time. Proceeding backwards, energy would be more and more differentiated and entropy would continually decrease. As a result it must follow that if the Universe is finite as regards matter and energy, it has been created, or at least the laws called natural have been modified at an epoch separated from our days by a finite time. J. J. S.

1863. *Hailstorm Artillery.* **W. N. Shaw.** (Nature, 64. pp. 159–161, June 13, 1901.)—The practice of firing off gunpowder to protect vineyards from hail is spreading. According to Pernter, cylindrical mortars are used in Austria; they are provided with large conical mouthpieces, and are made in three sizes, varying in length between 2 m. and 4 m., and taking charges of from 60 to 250, generally 180 g. of powder. Pernter finds that the vortex rings, discharged from the large mortars, have an initial velocity of 55 m. per sec., and reach a height of 400 m. As the storm-clouds are generally at the 1,000-metre level, the vortex rings would hardly reach the clouds even when discharged from an altitude of 500 m. The experiments thus do not account for the effects observed. H. B.

1864. *Fog Studies on Mount Tamalpais.* **A. G. McAdie.** (Monthly Weather Rev. 29. pp. 61–63, Feb., and 104–106, March, 1901.)—The first paper concerns the loss of the *Rio de Janeiro*, which was wrecked early in the morning of Feb. 22, 1901, while attempting to enter the Golden Gate. The loss is ascribed to the aberration of sound waves in the fog and also to a strong current. The second paper speaks of refraction of sound waves by fog surfaces and of fog dissipation. There is no mention of new experiments. Photographs of cloud surfaces, disturbed by wind, are reproduced. H. B.

1865. *Solar Activity.* **W. J. S. Lockyer.** (Roy. Soc., Proc. 68. pp. 285–300, June 24, 1901.)—From a re-examination of sunspot records from 1833 to the present time, a long period of variation is detected, having a mean value of 35 years. The length of the short period of mean value, about 11 years, oscillates from 9·5 to 12·5 years. From smoothed curves of the climatic variations by Brückner, and magnetic disturbances by Ellis, it appears that a similar periodicity of about 35 years is also connected with these phenomena. C. P. B.

REFERENCE.

1866. *Thermodynamic Theory of Capillarity and Electrocapillarity.* **G. Gouy.** (Journ. de Physique, 10. pp. 245–253, April, 1901.)—Paper largely mathematical, not adapted to abstracting. A. D.

LIGHT.

1867. *Molecular Refraction of Chloral Hydrate in Various Solvents.* **M. Rudolphi.** (Zeitschr. Phys. Chem. 37. pp. 426–447, June 18, 1901.)—The author gives the results of a large number of measurements of the density and refractive indices of solutions of choral hydrate in water, alcohol and toluene, made with a view to determine from which of these solutions the molecular refraction of the dissolved substance can be best calculated. All the four expressions giving the molecular refraction in terms of the molecular weight, refractive index and the density give numbers about equally concordant. The values obtained from the aqueous and alcoholic solutions differ less from those calculated from the atomic refractions of the constituent atoms than do those obtained with the liquid chloral hydrate; the toluene solutions give numbers considerably greater than the others. Although water is a strongly dissociating solvent and far removed in its action from alcohol and toluene, the former of which has a slight dissociating, and the latter a slight associating, action on dissolved compounds, it is found that the values of the refractive power of chloral hydrate in alcohol agree much better with those in water than with the numbers obtained with toluene. Hence the dissociating or associating power of a solvent is no measure of its suitability for use in refractometric investigations; nor is optical similarity between solvent and dissolved substance, since, although toluene most closely resembles chloral hydrate, the molecular refraction of the latter obtained from measurements on toluene solutions shows the greatest divergence from the value for the solid hydrate. The influence of the solvent on the molecular refraction of a dissolved compound may be very considerable, as it is strongly felt even in 20 per cent. solutions of chlorate hydrate in toluene. T. H. P.

1868. *Optical Constants of Biaxial Crystals by the Refractometer* **A. Cornu.** (Comptes Rendus, 133. pp. 125–131, July 15, 1901.)—The method depends upon the total reflection from the face of the crystal when it is placed in a sufficiently refracting medium; and the process of finding the six constants (three indices and three directions) is much simplified. The outline of the procedure is as follows: Determine the angles of total reflection in a series of azimuthal planes drawn through the normal to the crystalline face. Four planes will be found which give maximum or minimum values for the angle of total reflection. Determine these values and also the azimuths of these planes referred to any fixed plane through the normal. Repeating the observation for another face of the crystal, it will be found that of the four total angles in the second case three will be the same as three in the first case. Call these coincident three angles I_x, I_y, I_z respectively, and the fourth for the first face, I. For the orientation of the first face the fourth value at the second face is not required. Let now N be the index of refraction for the external medium, μ_x, μ_y, μ_z, the three indices for the crystal (N must of course be greater than any of these), then the equations—

$$\mu_x = N \sin I_x, \quad \mu_y = N \sin I_y, \quad \mu_z = N \sin I_z,$$

give these indices.

To find the orientation of the face operated upon, let α, β, γ, be the angles which the principal directions at the point make with the normal to the face, and let OA, OB, OC, be the azimuthal planes through the normal corresponding to the angles I_x, I_y, I_z. Then the following equation and two similar ones give the values of α, β, γ.

$$\cos^2\alpha = -(\cos \mathrm{AOB} \cos \mathrm{COA})/(\cos \mathrm{BOC}).$$

The optical vectors are thus completely found, and these results are very closely verified by experiments with the Abbe refractometer upon various crystals, especially the clinorhombic crystals of tartaric acid.

The fourth plane of incidence referred to above as giving an angle of total reflection I, leads to a fourth index μ peculiar to that face. It is given by

$$\mu = \mathrm{N} \sin \mathrm{I},$$

and is intermediate between μ_x and μ_z. It can, however, be distinguished from μ_y by the relation—

$$\mu^2 = \mu_x^2\cos^2\alpha + \mu_y^2\cos^2\beta + \mu_z^2\cos^2\gamma,$$

as well as by the previous formulæ. This fourth plane of incidence has the peculiarity that it contains the normal to the ellipsoid of elasticity at the point where the latter is cut by the plane. J. W. P.

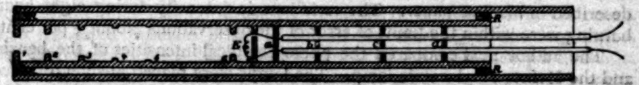
1869. *Oblique Refraction at a Spherical Surface.* **A. Champigny.** (Soc. Franç. Phys., Bull. 169. pp. 2–3; Discussion, p. 3, 1901.)—The known formula for the refraction of an obliquely incident pencil of rays, viz:—

$$\frac{\mathrm{R}\cos i + \mathrm{P}}{\mathrm{R}\cos r + \mathrm{Q}} = \mu \cdot \frac{\mathrm{P}\cos r}{\mathrm{Q}\cos i}$$

is stated. P and Q are the distances of object and image respectively from the refracting surface, R is the radius of the latter, i and r are angles of incidence and refraction, and μ is the index of refraction. A simple proof of this result is given, and its importance in questions of spherical aberration and photographic and microscopic lenses of large aperture is pointed out. In the discussion **A. Cornu** recalled a geometrical construction (given by Young in 1804 and independently by himself in 1864) whereby the pairs of conjugates can be determined. Points on the caustic can thus be found with great ease. J. W. P.

1870. *New Refractometers.* **P. Culmann.** (Soc. Franç. Phys., Bull. 168. pp. 4–5, 1901.)—A short account of some new instruments exhibited by M. Culmann to the Physical Society of France. (1) An instrument devised by Abbe some years ago to show that a luminous source emits more light when it is placed in glass than when surrounded by a medium, like air, of a lower index of refraction. The apparatus consists of two sheets of porcelain separated on the one hand by a block of glass fixed over one of the plates, on the other by a layer of air having the same dimensions as the block. Viewed by transmitted light the part of the porcelain which has the glass behind it is brighter than the other. (2) Various forms of the Abbe refractometer, for liquids, are briefly noticed. One of these permits of heating the liquid studied and observing its temperature; it may be used with white light. (3) An immersion refractometer. (4) An Abbe refractometer which permits of various measurements, such as the determination of the angle and the index of the substance. The method of total refraction for the index of refraction may be used with it, and homogeneous light must be employed. (5) A refractometer with variable angle for use in the case of liquids of high index, and for those which attack the glass of the Abbe refractometer. The liquid is caused to take the form of a prism with variable angle. Homogeneous light must be used. The precision of the instrument is less than that of the ordinary Abbe refractometer but its scale is more extended. All these instruments are manufactured by Zeiss of Jena. J. J. S.

1871. *Electrically Heated "Black" Body.* **O. Lummer** and **F. Kurlbaum.** (Ann. d. Physik, 5. 4. pp. 829–836, July, 1901. Communicated by the Phys. Tech. Reichsanstalt.)—This paper describes the electrically heated absolutely black body made for the radiation experiments in the Reichsanstalt. The innermost tube, 40 cm. long, is of special porcelain and is fitted with the diaphragms, 1, 2, 3, 4, 5, 6, and 7. The loose diaphragms, *a*, *b*, *c*, *d*, serve to carry the leads to the thermoelectric junction, E. This tube fits into a tube of platinum-foil the thickened ends of which are seen under the porcelain rings R R. The outer tube is of porcelain and is covered with asbestos. The platinum tube is heated by an electric current passing along its length, and when the steady state is reached the radiation from diaphragm 7 through the hole in diaphragm 1 is taken as that of an absolutely black body. This has been used up to a temperature of 1,520° C., above which the porcelain begins to conduct. J. B. H.



1872. *A New Pupilometer.* **C. Braileanu.** (Annal. Scientifiques de l'Univ. de Jassy, 1. pp. 262–264, 1901.)—An account is given of the arrangement devised by the author to measure exactly the dimensions of the pupil for a given intensity of light, in which the usual defects of such instruments are avoided. The two eyes are caused to receive the same quantity of light and the luminous rays are not stopped by the apparatus used to make the measurements. The arrangement consists of a sheet of glass on which are engraved two graduated lines meeting at an acute angle. Light from a lamp placed at various distances is caused to reach the eyes after reflection from the plate held in a suitable position. J. J. S.

1873. *Secondary Interferences in Crystalline Sheets.* **Damien.** (Soc. Franç. Phys., Bull. 163. pp. 5–6, 1901.)—An account of the apparatus of Damien which was constructed by Pellin. It consists essentially of two of Biot's hollow vessels superposed (quartz parallel to the axis) which are lit up by transmitted light and placed between a crossed polariser and analyser, an image being formed on a screen by projection. One of the two quartzes can be made to turn in the plane of its base so that its principal section makes an angle, variable at will, with that of the second quartz kept fixed. The first quartz can also be made to slide in the plane of its base so that the centre can be set at a definite variable distance from the centre of the second quartz. The two quartzes are hollowed so as to present in their centre a thickness so small that when each of them is placed between the polariser and analyser placed at extinction, the well-known rings of Biot, with the black mark at the centre, are caused to appear on the screen. J. J. S.

1874. *Sensitometry of Photographic Plates.* **J. M. Eder.** (Akad. Wiss. Wien, Sitz. Ber. 109. IIa. pp. 1103–1126, 1900.)—This paper contains the results of experiments on the benzine lamp, which the author employed as a secondary standard in the experiments described in his first article [Abstract No. 2157 (1900)]. The Scheiner benzine lamp is described and illustrated. The diameter of the wick-holder is 6 mm., the height of the flame is regulated to 28 mm., and the light shines through a slit 1 mm. high and 15 mm. broad in a screen distant 14 mm. from the centre of the wick. A red glass chimney covers the flame and screen, and has a hole corresponding to the slit. Since benzine is not a well-defined liquid, the Scheiner lamp is not to be recommended as a primary standard. The author tested it as regards constancy, using one sample of benzine; he measured the photo-chemical intensity by means of the Scheiner photometer and Hartmann microphotometer as described in his first paper. The variations in intensity during eight hours' burning were within the limits of error of the observations (about ½ per cent.).

The author next compared the photo-chemical intensities of the benzine and the Hefner amylacetate lamp. The lamps were placed at such distances that their intensities were approximately equal. Measurements were made at different distances and with different plates; the maximum variation in the results was about 1 per cent.; the mean value found for a Scheiner unit was 0·0756 Hefner units. The optical intensity of a Scheiner unit is 0·089 ± 0·002 Hefner units. The Hefner lamp was burnt in all cases without a chimney. The two lights give equal photo-chemical intensity at distances of 1 m. and 3·637 m. respectively.

The author discusses some details of his method of sensitometry, and mentions various precautions necessary to accurate work. A plate showing the Scheiner sensitometer disc in full size is appended. G. H. B.

1875. *Gradation of Photographic Images, with Lights of Different Wavelengths.* **W. de W. Abney.** (Roy. Soc., Proc. 68. pp. 300–321, July 9, 1901.) —The curve of gradation of a photographic plate is conveniently represented by taking the abscissæ as the time of exposure in powers of two, and the ordinates as transparency of deposit. The curve is approximately a straight line for some distance, and at each end tends to become parallel to the scale of abscissæ. The inclination of the straight portion is taken as representing the gradation of the plate. The paper describes a series of experiments undertaken to find how for any plate the gradation varies with the wavelength of monochromatic light producing the image.

Three different methods were employed. Firstly, exposure was made to monochromatic light through a screen of opacity varying in steps, the exposure being varied according to the photographic intensity of the light. Secondly, exposure was made simultaneously to four lights of different wavelengths issuing from the same prism, the time of exposure being varied with successive exposures on separate plates. Thirdly, while exposure was made, as in the last method, to four different colours, the time of exposure was varied by means of a revolving disc with apertures including varying angles.

The results given by the two latter methods are the same, but differ somewhat from those given by the first; this is due to the fact that the density of a photographic image does not depend merely on the product of intensity of light and time of exposure, but also on the magnitude of the two factors. All three methods, however, lead to the conclusion that the slope of gradation is least for the wave-length which gives maximum photographic effect, and is greatest in the red. This conclusion does not agree with Chapman-Jones's experiments, which point to a gradation slope which diminished with the wave-length; the difference may be explained by his use of orthochromatic plates. The author's first method gives results which apply to camera images taken under ordinary conditions. Calling the slope of gradation given by an amylacetate lamp 1, the slope for red light ($\mu = 0{\cdot}64$) is 1·65—that is, to produce the same slope the successive exposures to red light would have to be shortened in the ratio of 1 : 1·65; the slope for violet light ($\mu = 0{\cdot}42$) is 1·10. The author concludes that this variation in the slope of gradation must constitute a difficulty in three-colour photography.

G. H. B.

1876. *Instrument for Measuring Inclinations.* **C. Pulfrich.** (Zeitschr. Instrumentenk. 21. pp. 205–207, July, 1901.)—The apparent angle between two straight lines may be measured by means of a Dove's reflection prism, *i.e.*, a truncated isosceles prism, in which a ray entering at one face suffers internal reflection at the base, and emerges at the opposite face parallel to its original direction. On placing the eye close to the prism and looking partly along, partly through it, the object can be seen directly, side by side with its reflected image. Owing to inversion by reflection, a line and its image will only appear parallel when the line is parallel or perpendicular to the plane of reflection (*i.e.*, when the line appears perpendicular or parallel to the base of the prism). The prism is to be rotated about the line of sight until this is the case, the process being performed separately on each of the two lines in turn, whose inclination is to be measured. The difference of the angles of rotation, which can be read off on a divided circle, is equal to the angle required. The prism must remain fixed during the observations, and this method, therefore, cannot be used at sea. The author describes a hand-instrument (Neigungsmesser) for measuring the inclination of the sounding-wire to the horizon, devised by him for the German Deep Sea Expedition. Two Dove's prisms are placed side by side. One is fixed, the other is to be rotated first to the right and then to the left, until in either case the image of the wire in one prism is seen parallel to the image of the horizon in the other. The mean of the right and left readings being taken, the observation is independent of the zero point. The rays emerging from the Dove's prism pass through an arrangement of reflecting prisms and a third Dove prism. Zeiss was the constructor.

A. E.

1877. *Visual Images formed by Cylindrical and Astigmatic Lenses.* **J. D. van der Plaats.** (Ann. d. Physik, 5. 4. pp. 772–792, July, 1901.)—The article opens with a historical note and a brief preliminary description of the general appearances seen on viewing an object through a cylindrical lens. It is remarked that, though a real image can be thrown on a screen by a convex cylindrical lens, it will not be so sharp as the visual image; for every point of the object is drawn out to a line whose length is greater than the axial length of the lens, and, while the whole line will be visible on the screen, only a fraction of it will be seen in the visual image, since the rays going to form the remainder are cut off by the iris. In the mathematical discussion, the thickness of the lens, and chromatic aberration, are neglected. Starting with cylindrical lenses, the author first takes as object a straight line in a plane perpendicular to the optic axis, and discusses (1) the magnification for various inclinations to the axis of the cylinder, and (2) the amount and direction of rotation of the image-line when the object-line or lens is rotated. Next taking two straight lines as object, he finds the apparent change of inclination produced by the lens. An arrangement is described for throwing on a screen an imitation of the various appearances. A following section gives geometrical constructions for the formulæ connecting the distances of object and image. Three axes are drawn from a point L at angles of 60°. If LF = focal length, be cut off on the middle axis, and a transversal drawn through F cutting the other two axes at A and B, then LA, LB are the distances of an object and image from the lens. The effect of spherical aberration in curving the image of a straight line is shortly described. Astigmatic lenses are next discussed in a similar manner. A concluding section treats of the action of an ordinary lens held obliquely. A. E.

1878. *Zeeman Effect.* **N. A. Kent.** (Astrophys. Journ. 13. pp. 289–319, June, 1901.)—The author's observations confirm Reese's results [see Abstract No. 2158 (1900)] for certain zinc and cadmium lines, viz., that the separation of the external components for the normal triplet is not proportional to the strength of the magnetic field employed. He has also examined iron and nickel, with similar results for high values of the field strength, though in their case the proportionate falling off in the separation with increase in the field strength appears to be less. Comparing the effect of the magnetic field with the shift of the lines due to pressure, he finds that with iron the divisions of large and small pressure shift are not absolutely the same as those of large and small Zeeman separation. There appears to be no simple law connecting the separation of the various lines in either iron, nickel, or cobalt, but Preston's law is verified for mercury and calcium as well as for zinc, cadmium, and magnesium for the lines given by $n = 3$ in Kayser and Runge's formula, and for the lines given by $n = 4$ in both the subordinate series of zinc, cadmium, magnesium, and calcium; the ratio of the charge carried to the mass of the particle carrying it varies directly as n for the third set of lines in the second subordinate series, n being either 3 or 4. The results of a study of the anomalous iron lines are given in addition to determinations of the separation for many triplets and quartets. Self-induction in the spark circuit was found of great value for sharpening some of the lines.

W. E. T.

1879. *Use of a Scale in Spectroscopes with a Train of Prisms.* **H. Krüss.** (Zeitschr. Instrumentenk. 21. pp. 161–170, June, 1901.)—Simple spectroscopes with a single fixed prism are often provided with a third telescope tube, having a scale at its further end, whose image is brought into the field of view by reflection at the last prism surface. In the case of spectroscopes with a train of prisms set for minimum deviation by automatic adjustment there are difficulties in the way of furnishing this convenience, which have prevented its adoption hitherto. In the author's plan, the scale-tube, which is very short and wide, is fixed above the middle of the apparatus at a higher level than the prisms, with the centre of its objective in the rotation-axis of the telescope. The rays issuing from it are brought to the level of the eyepiece by two reflections, one vertically downwards by a 90° prism, and the other horizontally towards the eye, by a glass plate placed at an angle of 45° in the telescope tube, just behind the cross wires. Between prism and plate is a lens, consisting of two cylinders, for distorting the scale-image lengthwise and so adjusting its apparent length. The glass plate mentioned above is slightly wedge-shaped, in order that the second image, formed by reflection at the back surface, may be thrown outside the field of view. The lamp for illuminating the scale is fastened to the counterpoise of the telescope. A little automatic contrivance is attached for revolving the scale about its centre, by pressure of a spring, in order to keep it at the same distance from the object glass while the telescope rotates. With the ordinary arrangement of prisms, on moving the telescope, the image of the scale and the spectrum would appear to move in opposite directions. The following method is adopted, which makes them move the same way: the rays, on emerging from the train of prisms, fall upon a right-angled isosceles prism, having its hypothenuse silvered and turned away from the incident rays. These, entering one side at 45°, are refracted to the hypothenuse, whence they are reflected back to the same side, and thence totally reflected to the other side, whence they emerge at right-angles to their original direction.

A. E.

1880. *Photography of Infra-red Spectra of the Alkali Metals.* **H. Lehmann.** (Ann. d. Physik, 5. 3. pp. 633–658, June, 1901.)—Diffraction spectra of metallic vapours were photographed on plates sensitised by Burbank's process. Experiments on the solar spectrum showed that such plates are sensitive for the whole spectrum, from the ultra-violet down to 1000 $\mu\mu$ in the infra-red, except the region between *b* and F, where the addition of uranin or fluorescin will be of assistance. A Rowland plane grating was used. Before entering the slit of the spectroscope, the rays were filtered by Helmholtz's method, being made to pass through two slits and prisms. The blue spectrum of iron of the second order was utilised as a comparison spectrum, being photographed side by side with the first order spectrum of the element examined. The results are discussed in the case of Li, Na, K, Rb, and Cs; while Ca, Sr, and Ba will be dealt with in a future paper. Most of the lines measured fitted into Kayser and Runge's series, and in the case of rubidium, secondary series II was found. Five new rubidium lines, and nine new caesium lines were discovered. Of these nine, five could not be made to fit either known series or a hypothetical secondary series II. Enlarged reproductions of some of the original photographs are given. A. E.

1881. *Distribution of Intensity in Grating Spectrum of the D Lines.* **L. Zehnder.** (Ann. d. Physik, 5. 3. pp. 685–706, June, 1901.)—In the diffraction spectrum of a very intense sodium flame, a sharp dark line may be seen upon each of the bright D lines. These dark lines are presumably due to absorption by the envelope of the flame. The author has found, in observing with a concave grating, that by merely increasing the intensity of the source, and widening the slit, a splitting up of the dark lines takes place which is very similar to the Zeeman effect. He endeavours to explain this theoretically. By adopting certain simplifications, an approximate expression is derived for the intensity at a given point of the image of the slit, showing that the intensity varies from point to point and exhibits maxima and minima symmetrically situated with regard to the centre. The author also suggests the construction of a reflection echelon, not by piling plates, but by cutting steps out of a solid triangular block. Other things being equal, the steps would only need to be about one-quarter the height of those in a transparent echelon.

A. E.

1882. *Photographic Gratings.* **Cotton.** (Soc. Franç. Phys., Bull. 165. pp. 9–11, 1901.)—The author obtains diffraction gratings by photography without employing an object lens. In the ordinary interference apparatus fringes are observed which are only approximately rectilinear and equidistant. If they are illuminated by a parallel beam, the space common to the two beams produced is split up by interference surfaces forming a series of parallel and equidistant planes. A screen or photographic plate with a plane surface is therefore covered by a series of rectilinear and equidistant fringes forming a grating whose spacing can be determined beforehand. If a strictly monochromatic and parallel beam could be produced, and if the surface were perfectly plane, the grating obtained would be faultless. The greatest practical difficulty lies in the lack of parallelism due to the finite dimensions of the source. The author uses a Dufour mercury lamp with tube of fused quartz as a source. The gratings obtained, which contain some 1,200 fringes, or 38 per mm., show two spectra, one on each side of the central plane. They have the peculiarity of not showing any spectra of a higher order, owing to the fact that the amplitude of the vibrations varies as the luminous intensity. E. E. F.

1883. *Gratings made by Photography of Stationary Waves.* **A. Cotton.** (Soc. Franç. Phys., Bull. 169. pp. 4–7, 1901.)—This paper describes the production of gratings by means of photographing the interference fringes obtained when two mirrors are placed nearly parallel. The best results have been obtained by employing a modification of the Daguerrotype method, this being possibly due to the layer being principally sensitive only at the surface. A grating was shown about 5 cm. wide, having about 90 lines to the millimetre. This gave spectra of sufficient purity to separate the components of the yellow line of mercury. Copies are easily obtained by the bichromated gelatine process.

An interesting modification is described where the second reflecting plane mirror is replaced by a spherical one. In this case the interference rings when photographed form zone plates, which show all the phenomena of multiple images, &c. C. P. B.

1884. *Colouring Matters and Chemical Constitution.* **C. Camichel.** (Soc. Franç. Phys., Bull. 165. pp. 6–7, 1901.)—The best method of investigating colours by their characteristic bands of absorption is to define the latter by the point corresponding to the maximum or minimum of transparency according as the band is bright or dark.

This point is invariable; it does not depend on the thickness of the body, nor on the light falling on the spectroscope. For a solution it is independent of the concentration, if the body follows the law of Beer (proportionality of coefficient of absorption and of concentration), which is a very general one.

To determine the maxima and minima of transparency the method of the rectilinear diameter may be employed. A curve is constructed having wavelengths as abscissæ and coefficients of absorption as ordinates; this curve is cut by a series of chords parallel to the axis of abscissæ. The conjugate diameter of these chords obtained on joining their mid points cuts the curve very exactly at the point sought.

This method leads to the following results when applied to the indophenols:—

(1) The solutions of indophenols in alcohol, ether, &c., do not follow the law of Kundt.

(2) An ortho substitution in the phenol from which the indophenol is derived produces a considerable displacement of the minimum of transparency, whatever may be the solvent.

(3) A similar meta substitution produces a very slight displacement of the minimum of transparency towards the red or towards the blue.

The method of the rectilinear diameter may be employed for determining the formula of the phenols. J. J. S.

1885. *Röntgen and Secondary Rays, Matter, and Electricity.* **G. Sagnac.** (Annal. Chim. Phys. 23. pp. 145–198, June, 1901.)—Applications of secondary rays to the investigation of purity of metals. As to the influence of the position of a screen on its apparent transparency to Röntgen rays; the screen should be far enough to receive the Röntgen rays which come straight through the laminæ, while the secondary, which start in all directions from the laminæ and weaken with the distance, have become negligible. The influence of the secondary rays is much less important when the receiver is a luminescent screen. The influence of the order of a series of screens upon the apparent transparency of the system is discussed. This is followed by a discussion of the mechanism of discharge by Röntgen rays, taking secondary and tertiary radiations through the field into account: the result depends upon the thickness of the metal and the volume of the air, as well as upon the nature of the metal, the nature and the pressure of the gas, the strength of the electric field, and the form and area of the metallic surface. The differences due to the nature of the metal can be accounted for by the differences in the secondary radiations from the metals, these contributing to make the air more conductive. The bolometric energy of the secondary rays is probably much less than that of the Röntgen rays exciting them: but the activity of the secondary rays may enable Röntgen rays to be detected which in themselves might pass unperceived. The ultra-violet rays studied up to 1900 only dissipated negative charges, and had no effect upon gases, while secondary as well as Röntgen rays affect gases directly. Some peculiarities of the action of Röntgen and secondary rays are readily explained by means of the velocities and *vires vivæ* of the electric charges, liberated by the rays, under the influence of the electric field: and in certain cases these may present analogies to kathodic phenomena. P. Lenard has now [see Abstract No. 1028 (1900)] brought ultra-violet radiations into line with Röntgen and secondary radiations by showing that, at wave-lengths smaller than $0{\cdot}2\,\mu$, ultra-violet rays render gases conductive, and in certain cases discharge both positive and negative charges with practically the same velocity. The conclusion is probable, that secondary rays are Röntgen rays, very slightly penetrative, and possibly intermediate between the Röntgen rays from a soft tube and extreme ultra-violet rays. A part of the secondary radiation from heavy metals does not, however, present this analogy: in their most absorbable portion these radiations comprehend a radiation of negative electricity analogous to that of kathode rays and deviable radium rays; and this portion corresponds to the still more absorbable kathode rays excited by ultra-violet rays (Lenard); another analogy between Röntgen rays and ultra-violet. If d be the mean distance between particles, and λ the wave-length of light, the greater is $2d/\lambda$ the greater will be the amount of scattering and of that absorption which depends upon scattering; hence, mass for mass, gases should be more opaque than the corresponding liquids; and most gases should scatter ultra-violet rays, and do so the more energetically, mass for mass, the lower the pressure. This will explain the scattering of blue light by the sky. At about $\lambda = 0{\cdot}1\,\mu$ the absorption reaches a maximum, $2d/\lambda$ being then equal to about $\frac{1}{10}$ at atmo. pressure: and thereafter the index of refraction would begin to fall off along with λ, contrary to the law of normal dispersion. At some octaves into the ultra-violet, light would traverse prisms without refraction. If Röntgen rays be irregular successions of disturbances of the type $Ke^{-\alpha t} \sin 2\pi t/\theta$, the ordinary "absorption" due to resonance will be greatly reduced after passing through a maximum which is probably not far from that absorption of ultra-violet rays, $\lambda = 0{\cdot}1\,\mu$, by 0·1 mm. of air. Lenard's ultra-violet rays would probably be on the long-wave side of this maximum; Röntgen rays on the other side of it, and the more absorbable they are, then the nearer to Schumann's rays. Secondary rays would then be between ordinary Röntgen rays and Schumann rays: and their production would be in conformity with Stokes's law, whether the original Röntgen radiations be damped vibrations or undamped. A. D.

1886. *Action of Röntgen Rays on Conductors and Insulators.* **J. Semenow.** (Comptes Rendus, 132. pp. 1320–1322, June 3, 1901.)—McLennan has shown that in rarefied gases conductors positively charged are wholly discharged by kathode rays, while those negatively charged can only be discharged less or more completely according to the degree of vacuum. If ionisation were the only cause of discharge by Röntgen rays, the degree of rarefaction should influence both kinds of electrification alike. The present research shows that the ionisation of air by Röntgen rays is not the only cause of the discharge, and that the glass of an electroscope is polarised throughout by the Röntgen rays. The other effective cause of the discharge appears to be either the production of secondary rays, carrying negative charges, or the neutralisation of positive charges by the Röntgen rays themselves. A. D.

1887. *Transparency to Röntgen Rays.* **L. Benoist.** (Soc. Franç. Phys., Bull. 169. pp. 1–2, 1901.)—A discussion of the author's work on the subject [see Abstracts Nos. 1074 and 1273 (1901)]. Villard points out that metals having an atomic weight near to that of silver present anomalous emissive powers for the rays when used as the antikathode, analogous to those observed by the author for their transparency to the same radiation. Sagnac has noticed corresponding anomalies for the activity and degree of transformation of the secondary rays for the same metals. R. S. W.

1888. *Diffraction of Röntgen Rays.* **C. H. Wind.** (Phys. Zeitschr. 2. pp. 292–297; Discussion, pp. 297–298, Feb. 9, 1901. Paper read before the 72nd Naturforscherversammlung at Aachen.)—The author considers his experiments to be the only ones which have hitherto given a positive proof of the diffraction of Röntgen rays. Referring to the spreading of the fringes near the point of a wedge-shaped slit, as shown by photographs in Abstract No. 1897 (1901), the author, after vain attempts to produce Röntgen ray diffraction bands, sought for this spreading near the apex of the wedge-shaped image. The slit was formed from two pieces of platinum $\frac{1}{2}$ mm. thick, and the exposure lasted about 200 hours, several tubes having been used. Several pictures were obtained in which the widening occurs, although feeble. A diagram of the image given shows two bulbous enlargements, one much smaller than the other, the latter being nearer the apex. The size of the slit is microscopic, varying from $14\,\mu$ to $2\,\mu$, the wave-lengths being $0{\cdot}2\,\mu\mu$ and smaller. A description is given of the method of deducing the wave-length from the pictures by the use of a Fourier series. G. E. A.

1889. *Radio-active Material.* **F. Giesel.** (Chem. News, 83. pp. 122-123, 1901. From the Berichte, No. 19, 1901.)—Doubts are cast on the validity of Hofmann and Strauss's discovery of radio-active lead, on account of the difficulty of separation and detection of radio-active material, and the readiness with which insoluble sulphates, such as those of barium and lead, carry over active material. Giesel has confirmed Walkhoff's observation of skin wounds caused by radium rays, by applying 0·27 gm. of radium barium bromide in a capsule to the arm, when, after two or three weeks and much inflammation, the outer skin peeled off. The rays have a similar action on plant life, and also affect salts, glass, paper, &c. G. E. A.

1890. *Radio-activity of Radium Salts.* **P. Curie** and **A. Debierne.** (Comptes Rendus, 133. pp. 276-279, July 29, 1901.)—The authors have shown in previous papers how, by means of radium salts, radio-active properties can be given temporarily to any body, but more especially to water distilled from solutions of these salts. In this paper they give a theory to account for the experimental facts. We may suppose each atom of radium to act as a continuous and constant source of radio-active energy. This energy, stored in a body by radium, is dissipated in two ways: (1) By radiation (rays charged and not charged with electricity); (2) by conduction, *i.e.*, by gradual transmission to neighbouring bodies by means of liquids and gases (shown as induced radio-activity). The radio-active energy of a body goes on increasing till we come to a point at which the loss by these two means balances the gain, and then we have equilibrium. Except in special conditions, there is no gradual communication of activity through solid bodies. Thus if a solution is kept in a sealed tube, only the loss by radiation can subsist, and the result is a very high radio-activity in the solution. But in an open vessel the solution loses activity by conduction also, and when equilibrium is established the radio-activity of the solution is very weak. In a solid radio-active body it is only a thin superficial layer which produces induced radio-activity, so that the activity of the body does not sensibly diminish; but in solution, the salt divides its activity between itself and the water, and on distillation the water takes away a large part of the activity. W. C. H.

1891. *Phosphorescent Bacilli of the Baltic Sea.* **J. Tarchanoff.** (Comptes Rendus, 133. pp. 246-249, July 22, 1901.)—The cause of the luminosity of these bacilli is here traced to their respirative processes, and is found to vary with the oxygen consumption. The condition appears to be roughly periodic and may last from two weeks to three months. The effect of various physical agencies is investigated. Heat enfeebles the luminosity, and a temperature of 50° C. permanently destroys it. Freezing the liquid leaves the ice luminous for some time, but soon causes a temporary extinction; on reheating, the luminous condition is restored. Electric currents, either from battery or induction coil, localise the luminosity at the negative pole and eventually cause a temporary disappearance. Mechanical shocks and oscillations cause initial increase but eventual extinction. The effects of various organic and inorganic reagents is then stated, and the production of "luminous frogs" by injection of the liquid is described. J. W. P.

REFERENCES.

1892. *Interferometer.* **C. Fabry** and **A. Pérot.** (Annal. Chim. Phys. 22. pp. 564–574, April, 1901.)—The authors have for some time past been working with experimental apparatus in determining constants of length in terms of the wavelengths of various spectrum lines, and have had an instrument made embodying the improvements suggested by experience. This article contains details of the new instrument, illustrated by several engravings. C. P. B.

1893. *Simple Proof of Kirchhoff's Law of Radiation.* **E. Pringsheim.** (Deutsch. Phys. Gesell., Verh. 3. 7. pp. 81–84, 1901.)—This proof of Kirchhoff's law was partly contained in the report which the author read before the Paris Congress [Abstract No. 1070 (1901)]. It does not assume (as Kirchhoff's proof did) that perfectly black bodies, perfect reflectors and completely diathermanous bodies are possible. J. B. H.

1894. *Reflection and Refraction of Light.* **G. Sagnac.** (Archives Néerlandaises, 5. pp. 377–394, 1900.)—The author describes his theory of the propagation of light based on the discontinuity of matter, and applies it to the reflection and refraction of light in glass. He gives a more extended account of some parts of his theory which has already been described in *Science Abstracts.* J. J. S.

1895. *Arc Spectrum of Vanadium.* **J. N. Lockyer** and **F. E. Baxandall.** (Roy. Soc., Proc. 68. pp. 189–210, May 23, 1901.)—This paper gives a list of the vanadium lines reduced from photographs of the arc spectrum of vanadic chloride and oxide obtained by C. P. Butler with a large Rowland concave grating of 21½ feet radius. A discussion is given of the relations to other lists of vanadium lines published by Rowland and Harrison, and Hasselberg. C. P. B.

1896. *Spectroscopy Applied to Biology.* **A. Hénocque.** (International Physical Congress at Paris, Report, 3. pp. 586–614, 1900.)—The author deals with the methods employed for examining blood in its normal and its pathological states, the use of the spectroscope and hematoscope in physiological and clinical researches, and the spectroscopy of animal and vegetable pigments. E. E. F.

1897. *Diffraction Image of Slit.* **C. H. Wind.** (Phys. Zeitschr. 2. pp. 265–267, Feb. 2, 1901.)—Two drawings shown have been made from short and long exposure photographs respectively of a V-shaped slit illuminated by a point source. These show up the detail of the bands in geometrical image and shadow. A fine drawing has also been made, using Cornu's spiral, giving the lines of equal intensity of illumination over image and shadow. Two errors are noted in Gilbert's tables of the values of Fresnel's sine integrals. G. E. A.

1898. *Dispersion of Jena Glasses in the Ultra-violet.* **H. Trommsdorff.** (Phys. Zeitschr. 2. pp. 576–578, June 29, 1901.)—This Abstract of the author's Inaugural Dissertation in Jena (1901), contains an account of the method of experimenting, but the experimental results are not given. J. B. H.

1899. *Radiation of a Black Body.* **W. Michelson.** (Phys. Zeitschr. 2. p. 576, June 29, 1901.)—The author here replies to a criticism of his work which Lummer made in his Report to the Paris Congress [see Abstract No. 1045 (1901)]. J. B. H.

HEAT.

1900. *Persistent Changes in Glass and Shift of the Zero-point in Thermometers.* **L. Marchis.** (Zeitschr. Phys. Chem. 37. pp. 553–604, June 28, 1901.)—This is in continuation of a former paper [see Abstract No. 1686 (1899)] and deals with the hardening and annealing of glass, which is looked upon as a substance whose changes of condition are subject to hysteresis, so that its condition at any moment requires for complete specification some other variable in addition to, say, t and v. This variable, denoted by x, is called the "hardness"; it is taken as the measure of an assumed chemical condition which is subject to change, but of which nothing is known except from the experimental confirmation of results deduced from the hypothesis of its existence. The paper is too complex to be briefly abstracted, but the investigation follows the lines sketched in the above-named Abstract. A general conclusion is that for an isolated observation of a system subject to hysteresis to be of any real value the history of the variations of this system both before and after this observation must be known. R. E. B.

1901. *Thermometry of Precision.* **L. Marchis.** (Zeitschr. Phys. Chem. 37. pp. 605–612, June 28, 1901.)—The theory developed in the preceding memoir is here applied to explain the rationality of the procedure adopted on empirical grounds by the makers of thermometers for precise work, and some further practical details are described which the author's own investigations have suggested. The necessity of heating a thermometer to 100° and quickly cooling it to 0° some fifty or sixty times in succession before marking the fixed points is insisted upon, and also of repeating this process ten or fifteen times each time a thermometer is brought into use after lying by for a time in a place of practically constant temperature; and the practice of keeping a thermometer, which is to be used for a long series of temperature-determinations within a short range, *continuously* within that range, and of testing the shift of its zero-point only by an *auxiliary* thermometer, is theoretically justified. R. E. B.

1902. *Thermometer Glass at High Temperatures.* **W. McClellan.** (Frank. Inst., Journ. 152. pp. 63–72, July, 1901.) The experiments described in this paper are on the creeping of the fixed points of mercury-in-glass thermometers with time, particularly high temperature thermometers containing nitrogen under pressure. The experiments show that the creeping is greatly facilitated by keeping the thermometer for a long time at a high temperature. The creeping is really due to an annealing of the glass, and ceases when the annealing is complete. J. B. H.

1903. *Specific Heat of Alloys.* **D. Mazzotto.** (Journ. de Physique, 10. pp. 279–281, April, 1901.)—As regards the discrepancies between the various specific heats attributed to alloys, which were pointed out by van Aubel [see Abstract No. 72 (1901)], the author shows that these discrepancies are altogether systematic. In determining by the cooling method the specific heat of Lipowitz's or other alloys, either high values may be obtained, resembling those found by Spring, or the lower values which the author considers the true ones. The high values are obtained by subjecting the alloy to cooling after taking it beyond the fusing-point, and the low values by allowing the alloy to cool after keeping it for a considerable time at a temperature just below fusing-point. Thus for the same alloy, that of Lipowitz, the specific heat between 15° and 20° is 0·0476 by the first method and 0·0357 by the second method. The same applies to Wood's alloy. As regards those of Rose and Darcet, the heat developed by molecular change not only delays the cooling of the solidified alloy, but even heats it up. E. E. F.

1904. *Gay Lussac's Laws.* **A. Ponsot.** (Comptes Rendus, 132. pp. 1401–1404, June 10, 1901.)—These laws are only approximately adhered to, however small may be the pressure; the phenomena of dissociation show this. V being volume, *m* the number of molecules dissociated, T the temperature; that dV/dm is positive at constant temperature and pressure is a necessary consequence of dm/dT being positive. When the equilibrium is independent of or affected by the pressure it is independent of or affected by the temperature, and *vice versâ*. The dissociation tends to become complete when $V = \infty$, or when $T = \infty$. The volume of a component gas is always smaller than the volumes of the components into which it is broken up by dissociation. Boyle's law is also a limiting law when $V = \infty$; but Avogadro's is not. A. D.

1905. *Thermal Conductivity of the Human Skin.* **J. Lefèvre.** (Journ. de Physique, 10. pp. 380–388, June, 1901.)—The author made absolute determinations of the thermal conductivity of the living skin by measuring or calculating the coefficient of heat emission from the external surface *h*, the coefficient of the heat transmission through the skin *k*, and the coefficient of the heat restoration on the inner surface of the skin *l*. The subject was immersed, always to exactly the same depth, in 68 litres of water at temperatures of 5, 12, 18, 24, and 30° C.; the skin area in contact with the water was estimated with the aid of a tightly-fitting garment. The external skin temperature was measured with the help of a thermocouple, consisting of a disc of iron surrounded by a flat ring of German silver, contained in an ebonite tube; the inner temperature by inserting a thermocouple of needle shape, likewise contained in an ebonite tube, vertically through the skin to the depth of 2 mm., the skin thickness being about 1·5 or 2 mm. The coefficient *k* is found to be of the order of the conductivity of guttapercha, namely, 0·00083 at 30° C., and only 0·00047 at 5°. The heat emission *h* from the skin varied little with the temperature of the external medium. But the *l* was 0·00020 at 30° and increased rapidly as the temperature of the external medium was diminished to 0·00120 at 5°. H. B.

1906. *Atomic and Molecular Volumes.* **J. Traube.** (Ann. d. Physik, 5. 3. pp. 548–564, June, 1901.)—This is a discussion of the results of many calculations from data given by S. Young and others. Two of the conclusions are that for liquids, just as for gases, we must distinguish *three* volumes, viz., that of the actual material of the atoms, that made up of the sum of the atomic volumes which equals van der Waals' *b*, and a molecular co-volume or excess of the molecular volume over *b*; and that *b* increases in the ratio $1 : \sqrt{2}$ as a liquid changes into a gas. The ratio of the volume of a substance at absolute zero to its volume at the critical point is also estimated as 1 : 3·88 on the average. R. E. B.

1907. *Heat Absorption by Carbon Dioxide.* **S. Arrhenius.** (Ann. d. Physik, 4. 4. pp. 690–705, 1901. Paper read before the Swedish Academy of Science, Jan. 9, 1901.)—The heat sources used were a Leslie's cube at 100°, and a hollow copper vessel kept at — 80° C. by a freezing mixture applied externally. The rays were passed along a thick iron tube closed by rock-salt end plates 1 cm. thick, and filled with CO_2 from a cylinder, a thermopile acting as receiver. By taking length of tube × pressure in atmospheres (l) as the equivalent length of the CO_2 column, numbers are found which agree well with Tyndall's, and which extend the observations up to an equivalent length of 355 cm. They are also in fair agreement with those calculated from the empirical formula:

$$\log a = -\mathrm{D}\left\{(1 + \mathrm{B}l)^c - 1\right\}$$

where $a = 1 - \frac{\mathrm{A}}{100}$, A being the percentage absorption.

$\mathrm{D} = 0{\cdot}0028$ for the first source, and
$0{\cdot}0040$ for the second.
$\mathrm{B} = 1$ and $c = 0{\cdot}25$.

The above formula is applicable between $l = 10$ and $l = 350$. The problem of heat absorption by the earth's atmosphere is then speculated upon, and Ångström's treatment of it [Abstract No. 807 (1901)] criticised adversely.

G. E. A.

1908. *Ratio of Specific Heats of Gases.* **W. P. Boynton.** (Phys. Rev. 12. pp. 353–358, June, 1901.)—Van der Waals' characteristic gives for this ratio—

$$1 + (\mathrm{R}/\mathrm{C}_v)\left\{1 + 2a(v - b)/(pv^3 - av + 2ab)\right\},$$

which is represented by $1 + (\mathrm{R}/\mathrm{C}_v)(1 + 2a/pv^2)$ with sufficient approximation under ordinary circumstances. Another formula is obtained by assuming that with this characteristic the ratio is equal to V^2/pv, where V is the velocity of sound in the gas [but the percentage-error of the whole ratio on this assumption is equal to that of the correctional-term $2a/pv^2$ in the other formula]. A third formula [still less approximate] is given, and all three are compared by calculations for air, H_2 and CO_2.

R. E. B.

1909. *Mechanical Interpretation of the Principles of Thermodynamics.* **A. Séligmann-Lui.** (Comptes Rendus, 133. pp. 30–33, July 1, 1901.)—For the motion of a conservative system to be stable $\Sigma d\mathrm{V}$ must always be zero, as also is $\Sigma d\mathrm{U}$, where U and V are respectively the whole energy and the kinetic energy of the system, and Σ extends over all its parts. For no part to gain energy at the expense of another $d\mathrm{U}/d\mathrm{V}$ must be the same everywhere, and it is characteristic of the temperature T, or is $f(\mathrm{T})$. If in a Carnot's cycle $d\mathrm{V}$ is the kinetic energy lost by the source at T_2, and gained by that at T_2, the whole energy lost by the former is $f(\mathrm{T}_1)d\mathrm{V}$ and that gained by the latter is $f(\mathrm{T}_2)d\mathrm{V}$, so that the efficiency is $1 - f(\mathrm{T}_2)/f(\mathrm{T}_1)$, and thus $d\mathrm{U}/d\mathrm{V} = \mathrm{MT}$, where M is independent of the working body and of T. The kinetic energy V is then identified with the entropy $\int d\mathrm{U}/\mathrm{T}$: further, M must be positive. It is concluded from this that the kinetic energy of gases is a function of their volume, and that therefore the kinetic theory of gases must be entirely abandoned; also that, if during any transformation a body has received increments $\Delta\mathrm{U}$ and $\Delta\mathrm{V}$ of intrinsic and kinetic energy from bodies at T, the part of $\Delta\mathrm{U}$ made up of electrical energy cannot exceed $\mathrm{MT}\,\Delta\mathrm{V} - \Delta\mathrm{U}$.

R. E. B.

1910. *The Characteristic Equation and the Theory of Cyclical Motion.* **J. D. van der Waals.** (Archives Néerlandaises, 4. 3. pp. 231–269, 1901.)—The theory of cyclical motion applied to a diatomic gas gives—

$$\left\{p+(\partial P_v/\partial v)_T\right\}(v-b)=\frac{2}{3}L_m$$

$$\left\{p+(\partial P_v/\partial v)_T+(\partial P_b/\partial b)_T\right\}(b-b_o)=2L_a$$

for the molecular and atomic motions respectively, L_m and L_a being the corresponding kinetic energies, P_v and b being functions of v and T, P_b a function of b and T, and b_o the value of b for $T=0$, $p=\infty$. Further, since $L_m\equiv\frac{3}{2}RT$, the entropy is given by—

$$d\eta=\frac{3}{2}R\left[d.\log\left\{v-b)^{\frac{2}{3}}L_m\right\}+(L_a/L_m)\,d.\log\left\{(b-b_o)^2L_a\right\}\right],$$

which for integration requires L_a/L_m to be constant or a function of $(b-b_o)^2L_a$: reasons are given for assuming this ratio equal to $\frac{1}{3}$, whence—

$$\eta=R\log\left\{(v-b)(b-b_o)T^2\right\},$$

from which is obtained, on not very clear grounds, for infinite dilution, $C_v=\frac{5}{2}R$, and consequently $C_p/C_v=1{\cdot}4$. The above results follow from ordinary thermodynamics assuming that the characteristic and the intrinsic energy of a gas are respectively of the forms—

$$\left\{p+(\partial P_v/\partial v)_T\right\}(v-b)=RT$$

$$\epsilon=F(T)-T^2\partial_v(P_v/T)/\partial T-T^2\partial_b(P_b/T)/\partial T,$$

which give in general—

$$p+(\partial P_v/\partial v)_T+(\partial P_b/\partial b)_T=RTF(b-b_o).$$

For a triatomic gas the matter is more complicated, but a near approximation seems to be—

$$p+av^{-2}+\alpha(b-b_o)=fRT/(b-b_o),$$

where a, α, f are constants, and $2>f>1$. Complicated calculations from the data for CO_2 lead to the conclusion that b is independent of T and given by—

$$\frac{1}{2}(b-b_o)/(v-b)=1-\left\{(b-b_o)/(b_l-b_o)\right\}^2,$$

where b_l is the value of b for $v=\infty$; and for this gas $f\mathrel{\hat{=}}2$, $a=0{\cdot}00874$, $\alpha=0{\cdot}138$, $b_o\mathrel{\hat{=}}0{\cdot}0007$, $b_l\mathrel{\hat{=}}0{\cdot}0026$.

A general conclusion from the theory is that as matter becomes more and more condensed, its state approximates to that in which all the molecules are resolved into atoms. R. E. B.

SOUND.

1911. *Monaural Localisation of Sound.* **J. R. Angell.** (Science, 13. pp. 775–777, May 17, 1901; also Psychological Review, May, 1901.)—The subject of the experiments was a man totally deaf in one ear, total nerve deafness indicating disease of the labyrinth of that side. The uninjured ear was decidedly more acute than the average.

Imagine the man seated in the centre of a large clock-face, the XII being in front of him, the VI behind, the III and IX being to his right and left respectively, and the left ear being the deaf one.

Pure tones, such as the sounds of tuning-forks, cannot be localised at all. Complex sounds can be localised with an ease which increases with the number and audible nature of the partial tones, except in the region from VIII to X, *i.e.*, directly opposite the deaf ear. In monaural hearing intensity of the sound can only afford very ambiguous information, as an alteration may be due to change of distance, change of intensity in the note itself, or change in direction. The subject cannot localise simple sounds, for they are capable of variation only as regards intensity. Complex sounds he can localise, no matter how the distance or intensity varies. Localisation seems, therefore, to be due to the modifying of the partial tones, to which the meatus pinna and the bones of the head all contribute. W. C. O.

1912. *Sounding Flames and Flame Telephony.* **H. T. Simon.** (Elektrotechn. Zeitschr. 22. pp. 510–514, June 20, 1901. Paper read before the Elektrotechn. Verein, April 23, 1901.)—The author observed in 1898 that an arc-lamp reproduced the chatter of an induction coil worked in the next room: it was found that the two circuits were parallel to one another for a very short distance, and the steady current in the lamp circuit had interrupted induced currents superimposed upon it: but these could only be very small; so microphone currents were tried, passed through one coil of a transformer while the lamp current was passed through the other; and the experiment succeeded, the arc-lamp giving out the sound without change of timbre, like an ideal loud-speaking telephone. Microphones for currents up to $\frac{1}{2}$ ampere gave the best results. The next improvement (E. Ruhmer) was to put the microphone with a resistance in parallel with the lamp: this got rid of the transformer and of the microphone battery. Then came Duddell's remarkable work (The Electrician, Dec., 1900), in which capacity and self-induction are taken account of in such a way as to confine the microphone currents to the flame and to exclude them from the general system. He put a capacity and a transformer in parallel with the lamp, and passed the microphone current through one coil of the transformer. This was an improvement, but the author and Reich have found that, when the lamp is fed by an accumulator battery, Duddell's arrangement may even be harmful, but that it must be used when the lamp circuit has much self-induction and particularly when a dynamo is used. But it may be pointed out that in Duddell's system resonance, which can only reinforce one component, must be avoided; and the self-induction and capacity must be so chosen that for the deepest note to be reproduced (say $n = 300$ per second), $2\pi n$ shall not be equal to but shall always be greater than $1/\sqrt{LC}$: say L is that of a thick-wired 300-turn coil and C is

5 microfarads. If C be too great, the condenser does not come up to full charges at each oscillation, and the effect is deteriorated. Other combinations may be used; and one devised both by the author and Reich and also by Ruhmer, is to put a capacity across the lamp circuit and between this and the lamp to branch a microphone circuit on the lamp circuit with both a self-induction and a resistance on the main circuit between the ends of the microphone branch, the resistance being such that the voltage on the microphone is about 4 volts. The loudness increases with the strength of the lamp-current and with the length of the arc. Duddell first had the boldness to use arcs of 10 cm., such as are now used; either impregnating his carbons with salts or using sufficient voltages (110 to 200 volts). The volume of the arc seems to undergo periodical variations in consequence of the varying heating; the consequence of this is the production of air-waves. The variations of temperature would be about 0·8° C., which is sufficient. Explanations have been put forward according to which the vibration is due to a varying current in the terrestrial magnetic field: but the sound is not made louder through putting the arc in a strong magnetic field. The author is still experimenting as to the cause of the phenomenon, in the light of the more recent knowledge as to the conduction of electricity in gases. Braun has pointed out that the increment in the Joule effect is proportional to $i \, . \, \delta i \, . \, r$, and should therefore be greater the stronger the lamp-current: but we cannot treat the lamp as a simple metallic conductor, though there does seem to be a true Ohm effect. Experiment is going on as to this; but in the meantime it would seem that Braun is right. The converse phenomenon would be the impact of sound waves effecting an alteration in the volume of the arc gases, and this producing variations in the current in the lamp-circuit, which might be reproduced as sound in a telephone: so that an arc-lamp might be used as a microphone. This can be done if the sound waves be concentrated upon an arc confined in a lime block. More faintly, an arc lamp may repeat what has been said near another arc-lamp in the same circuit with it (J. H. West). By taking the current of the field magnets of a (shunt) dynamo through one coil of a transformer, and through the other coil a microphone current; and by putting a capacity across the field magnet shunt and a choking coil in the shunt, we can make all the lamps on the circuit speak simultaneously. Some recent tests in Frankfurt have been conspicuously successful in this; but with ordinary lamps a suitable capacity must be arranged in parallel with the main-current coil of the regulator. With alternating currents there is both the transmitted sound and the tone belonging to the alternations. With three-phase currents, if we take the light of three wires and three carbons at 120° on to one carbon, and pass the microphone currents over the field magnets, we can produce the same effect as with a direct current; apart always from the imperfection introduced by departures from the sinusoidal curve. For telephony without wires, we might use selenium cells, which have recently been greatly improved (Clausen and v. Bronk, Berlin), having now a resistance of 18,000 ohms in the dark and 9,000 ohms in diffused daylight, and being now prompt in response. As the temperature of the arc varies the radiations vary: and this is sufficient to work a telephone. Graham Bell's photophone of 1880—a vibrating membrane, silvered, reflecting light on to a selenium cell—could not work beyond 250 metres: the present plan disposes of far more powerful beams, which may be concentrated as we wish. The selenium cell is so sensitive that if a Siemens and Halske polarised relay be arranged in its circuit so as to operate the circuit of an incandescent lamp, it is sufficient to light a match at some distance from the selenium cell to make

the incandescent lamp light up. The Arons lamp works well for this kind of photophonic transmission: an arc between mercury electrodes in a vacuum: the arc itself is silent and the only variations are in its intensity. The constant current of the selenium cell is kept from the telephone by connecting one terminal of the telephone with a condenser arranged parallel to the selenium cell. Ruhmer has photographed the variations of radiation upon a moving film: and on again passing this film between a light and a selenium cell, with telephone, he has obtained a reproduction of the original speech. Duddell has obtained a sinusoidal current from a direct by putting a low-resistance self-induction and a capacity in parallel with a lamp; the lamp spontaneously gives a sound corresponding to the value of *n*: a result which is of extreme importance from the technical point of view, since L and C may be adjusted so as to give *n* any required value, and the pure sinusoidal form is of great consequence in wireless telegraphy. Much remains to be done in the study of selenium cells. [See also Abstracts Nos. 846, 850, 1090, and 1234 (1901).]

A. D.

1913. *Velocity of Sound in Hot Air.* **E. H. Stevens.** (Deutsch. Phys. Gesell., Verh. 3. 5. pp. 54–56, 1901.)—The velocity of sound in hot air was found by means of a resonance tube of porcelain closed at one end, which was heated in a coal stove. The first mode was determined by displacing a narrow hearing tube in the resonance tube until the note vanished. The velocity at 950° was found to be 686 m. per sec., instead of the theoretical value 701·8. This gives 1·34 for the ratio *k* of the two specific heats. Further experiments were made with an electrically heated tube. It was found that the divergence between theoretical and actual values increases with the temperature. At 1,000° the actual velocity is 700·3 m. per second instead of 716, and *k* is 1·340.

E. E. F

ELECTRICITY AND MAGNETISM

THEORY AND ELECTROSTATICS.

1914. *On the Maximum Value and Physical Significance of Maxwell's Function T_{me}.* **A. Garbasso.** (N. Cimento, 1. pp. 401–444, June, 1901.)—This treatise refers to Maxwell's division of the kinetic energy of a system of electric currents in material bodies into three parts, T_m, T_e, and T_{me}, in which T_m is the kinetic energy of moving masses assuming no currents to exist, T_e the kinetic energy of the currents, the masses being at rest, and T_{me} that part if any of the kinetic energy which is due to the simultaneous existence of electric currents and moving masses. The Lagrangian force component is similarly divided into X_m, X_e, and X_{me}. It may be put also into the form $K\dot{x}\dot{y}$, if x be the angle turned through by a circuit revolving about an axis, y the quantity of electricity which has passed through a section of current since a given epoch. Any such term depends for its existence on a connecting link between matter and electricity.

Maxwell concludes that no such term, and therefore no such connection, exists. The experiment which led him to this conclusion is described in Electricity and Magnetism, vol. ii. p. 201. The writer considers Maxwell's experiment inconclusive, on the ground mainly that the mercury into which the end of the wire is dipped tends to extinguish the force X_{me}, if it exists.

The writer proposes to introduce an electromotive force reducing to zero a magnetic field, thereby avoiding the damping or extinguishing of the motion which would follow from Foucault's currents. Such an e.m.f. may, for instance, be formed by exciting an electric current in a metallic ring; and he discusses what is the best metal for the ring, having regard to density and specific resistance, and what is its best form. The apparatus employed by the writer is described, and its principal constants calculated by the aid of the theoretical formulæ. The results obtained are: (1) To a first approximation everything goes on as if no connection existed between the motion of electricity and that of matter; (2) but taking into account higher terms of a series, there is room for the hypothesis that such connection exists, and that it has special properties; (3) if in certain cases a term $K\dot{x}\dot{y}$ is found to exist, then the connection above must exist. It does not, however, follow that we can in any given case determine with certainty the direction of the current in the conductors. S. H. B.

1915. *On the Internal Tensions of a Fluid Magnetically or Dielectrically Polarised.* **L. Giuganino.** (N. Cimento, 2. pp. 20–41, July, 1901.)—The writer examines certain developments by Duhem and Helmholtz of Maxwell's theory, which represents magnetic and electrical phenomena by a system of elastic pressures and tensions in a fluid surrounding the magnetised or electrified bodies.

He assumes a perfect fluid capable of magnetic polarisation, whose specific volume at x, y, z is denoted by σ, and its thermodynamic potential at constant volume is—

$$\int \phi(\sigma) d\omega,$$

the integral being throughout space. A magnetic field having potential V is created. This polarises the fluid, and the potential of the polarised mass is U. A, B, C are components of the induced magnetisation, and A = M cos (Mx), &c The thermodynamic potential can be put in the form—

$$\Omega = \int \phi(\sigma) d\omega + \int A \frac{dV}{dx} d\omega + \&c.$$
$$+ \frac{1}{2} \int A \frac{dU}{dx} d\omega + \&c.$$
$$+ \int F(M\sigma) d\omega,$$

where F denotes a certain function. He finds that if σ varies and $\partial\sigma$ denotes consequent variation, and u, v, w the displacements of x, y, z, then—

$$\partial_\sigma \Omega = \int \left\{ \frac{\partial}{\partial\sigma}[\sigma F(M\sigma)] + \frac{1}{2}\frac{\partial(U + 2V)}{\partial x} A + \&c. \right\} \left(\frac{\partial u}{\partial x} + \frac{\partial v}{\partial y} + \frac{\partial w}{\partial z} \right) d\omega,$$

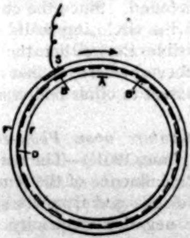
which differs from Duhem's theory by the integral—

$$\int \left(\frac{1}{2}\frac{\partial(U + 2V)}{\partial x} A + \&c. \right) \left(\frac{\partial u}{\partial x} + \frac{\partial v}{\partial y} + \frac{\partial w}{\partial z} \right) d\omega$$

In like manner, considering Helmholtz's theory, he finds that certain terms are not correctly given. His conclusions are : (1) If a polarised body which is compressible has only induced electric or magnetic charges, and can be considered as a perfect fluid, it is not possible to find any system of elastic forces equivalent to the given polarisation ; (2) if the polarised body be considered as an imperfect fluid, there exists either an infinity of systems of tensions and pressures equivalent to the polarisation or none at all ; (3) the expression for these tensions and pressures cannot be reduced to that of Maxwell and Helmholtz. S. H. B.

1916. *Open Currents.* **V. Crémieu.** (Comptes Rendus, 132. pp. 1108-1110, May 6, 1901.)—If, as the author claims to have proved, electric convection produces no magnetic effect, it follows that "open currents" must exist, and he demonstrates their existence as follows :—

On an ebonite disc D, 37 cm. in diameter and 2·5 mm. thick, 25 segments



are gilt. The disc turns about a central axis between two fixed ebonite discs F and F′. The disc F′ bears a tin-foil armature S twice as broad as the moving armatures. Two brushes, B, B′, 60 degrees apart, are in contact with the moving armatures. When S is charged, the armature in contact with B acquires an induced charge, which passes on to B′, where it is discharged. If B and B′ are connected there will be electric convection between them on the one hand and electric conduction on the other. At A is placed one needle of an astatic system. If B and B′ are joined through a galvanometer, the latter shows a deflection while A does not. If B and B′ are joined through a coil placed near the lower needle of the astatic pair, a deflection of A is observed as soon as S is charged, and varying in direction with the sign of the charge. The current circulating in BB′B is therefore an open current. [See also Abstracts Nos. 1666 (1900), 144 and 1100 (1901)]. E. E. F.

DISCHARGE AND OSCILLATIONS.

1917. *Electricity Dispersion in Higher Atmospheric Strata.* **H. Ebert.** (Ann. d. Physik, 5. 3. pp. 718–724, June, 1901.)—Abstract from Bayer. Akad. Wiss. Sitz. Ber. Math.-Phys. Klasse, 30. p. 511, 1900 ; 31, p. 35, 1901.)—Together with R. Emden, the author made three balloon ascents on June 30 and Nov. 19 (mist below), 1900, and Jan. 17, 1901 (clear day, country covered with snow). Determinations of dispersion were made by Elster and Geitel's method. Near the surface, the dispersion of negative charges is much more rapid than that of positive charges, so that a kind of unipolar conduction results. In higher strata both discharges become much more rapid, and the difference between the positive and negative discharges tends to disappear. In the serene atmosphere above 3,000 m. the two dispersions were practically equal. Much depends, however, on the atmospheric conditions, and the unipolarity may extend into the higher strata. Water condensation impedes the mobility of the ions. H. B.

1918. *Electric Leakage in Enclosed Volumes of Air.* **J. Elster** and **H. Geitel.** (Phys. Zeitschr. 2. pp. 560–563, June 22, 1901.)—Following on Geitel's earlier experiments [see Abstract No. 635 (1901)] the authors seek to determine the cause of the electrical conductivity which is observed in air even in the absence of all influences known to produce such conductivity. They find that the gradual increase of conductivity up to a certain limiting value cannot be due, except to an insignificant extent, to the settling of dust originally present in suspension, nor yet to variations of humidity of the air. In caves and in cellars of houses, where the air is almost stagnant, an abnormally high conductivity was found. Since the enclosed air behaves as if there were present in itself or in the enclosing walls small traces of radio-active substances, it appears possible that either the radio-active substances at present known are scattered everywhere, or that radio-activity is itself a property belonging to a small extent to other bodies also. W. C. H.

1919. *Influence of Temperature upon Photo-electric Effect.* **J. Zeleny.** (Phys. Rev. 12. pp. 321–339, June, 1901.)—The author describes, and gives the results of, experiments on the influence of the temperature of a body upon the rate at which electricity is discharged from its surface by ultra-violet light. From a platinum wire the negative electricity is at first discharged more slowly as the temperature is increased ; but the rate of discharge reaches a minimum and then increases as far as the highest temperature used (about 700° C.). The rate of discharge produced by the light also depends upon the previous history of the wire. When the wire comes to a certain temperature from a higher one, the rate of discharge is much greater than if a lower temperature had been used just before. After the reduction of temperature the rate of discharge gradually becomes smaller with time, showing that the large conductivity at first is due, partly at least, to the fact that the wire reaches its steady state but slowly. With an iron wire we also find a descent at first to a minimum rate of discharge, but the final value is many times that for ordinary room temperature.

Heating the wire does not change the inability of ultra-violet light to discharge positive electricity, even though the wire is raised to a temperature where, on account of the heat alone, the positive electricity is being discharged. From the nature of the results of the above experiments the author concludes that the variations observed are mostly due to changes taking place at the metal surface, and not in the gas between the electrodes. The experiments are to be continued. W. C. H.

1920. *Spark Discharge accompanying High-frequency Oscillations.* **K. E. Guthe.** (Ann. d. Physik, 5. 4. pp. 818–828, July, 1901.)—A small jar is provided with a spark-gap upon which ultra-violet rays are incident, and its spark potential is known. This jar is then charged in an oscillatory manner from a larger jar through a connection having appreciable inductance and resistance. It, at first, appeared as though the spark potential of the smaller jar was not now the same as under statical conditions. Careful experiments and calculations, however, establish that the jar sparks, during the surgings, immediately the "static" value of potential is reached. E. H. B.

1921. *Electric Discharge in Helium.* **W. Heuse.** (Ann. d. Physik, 5. 3. pp. 678–684, June, 1901.)—Collie and Ramsay have stated that a tube containing helium shows, at atmospheric pressure, the appearances usually looked for in other gases at greatly reduced pressures when an electric discharge is passed. The author here shows that a helium tube gives the same form of discharge at a pressure of 28 mm. as does a hydrogen tube at 4 mm., and that the stratified discharge can be produced in helium at 5 mm., while in nitrogen, in the same tube, 1 mm. is the highest pressure at which stratifications appear. The potential gradient in helium is very small as compared with other gases under similar conditions. The kathode fall of potential in the same gas is given as 253 volts. The potential gradient along the whole length of a tube containing helium was measured and was found to give results similar to those obtained by Graham for nitrogen. R. S. W.

1922. *Anode Rays.* **W. Hibbert.** (Elect. Rev. 48. pp. 962–963, June 7, 1901.)—During exhaustion of a tube there are both anode and kathode rays. The line of discharge and concentration for each varies according to the pressure. At particular, though differing, pressures it is possible to get convergence of either. A. D.

1923. *Potential Distribution near the Kathode.* **A. Wehnelt.** (Phys. Zeitschr. 2. pp. 518–527, June 1, 1901.)—By means of a special tube the author is able to measure the potential at points in the discharge not only along the axis but along the diameter of the cross section of the tube. From numerous measurements equipotential surfaces near the kathode can be drawn. In a tube in which the disc electrode is far removed from the walls, these are smooth surfaces concave to the kathode. If the walls of the tube are near, the surface is rather more complicated. Comparatively great potential gradients are found across the section of the tube in the kathode dark space. The potential is found to rise in a continuous manner along the axis of the tube as the kathode recedes, thus disagreeing with Graham's results, the latter finding maxima and minima. Testing the matter more under Graham's conditions, his results are shown to be due to a defect in the apparatus. At high pressures the equipotential surfaces are parallel to the kathode. The distortion of these by a magnet is investigated experimentally. The temperature of the gas carrying the discharge increases in a continuous manner as the boundary line between the dark space and negative glow is crossed. R. S. W.

1924. *Electric Resonance in Rarefied Air.* **A. Turpain.** (Comptes Rendus, 132. pp. 1315–1317, June 3, 1901.)—The methods of previous papers [Abstracts Nos. 1846 and 2246 (1900)] are extended to the wires concentrating the Hertzian field and the region surrounding these wires and the resonator. The oscillations which excite a resonator have a wave-length twice the length of the resonator. A. D.

1925. *Passage of Electric Waves through Systems of Resonators.* **E. Aschkinass** and **C. Schaefer.** (Ann. d. Physik, 5. 3. pp. 489–500, June, 1901.)—In the endeavour to clear up certain problems as to the mechanism of optical absorption and dispersion the following experiments with electric waves were conducted. A parallel beam of electric waves of length 9 cm. in air was generated and allowed to fall upon a set of small resonators equally spaced throughout a wooden frame a foot square. Ten such sets of resonators of various sizes were made and used in succession in air and immersed in various liquids to find in each case which set gave the maximum absorption of the waves. The lengths of the waves in the various liquids were thus determined. The ratio of wave-lengths in air and in a liquid, compared with the square root of its dielectric constant, gave a good agreement for the liquids tested, as follows :—

Liquid.	Ratio of Wave-lengths.	$\sqrt{K}$
Benzol	1·52	1·52
Ether	2·04	2·07
Acetone	4·7	4·6

E. H. B.

1926. *Application of the Calorimeter to Measurement of Electric Waves.* **F. Harms.** (Ann. d. Physik, 5. 3. pp. 565–596, June, 1901.)—By adoption of a convenient calorimetric method for the detection of electric waves the following results were obtained :—

(1) A series of substances were proved to exhibit anomalous electric absorption.

(2) This anomalous electric absorption is connected with an increased conductivity.

(3) The theoretically derived law, as to the variation of conductivity with frequency of vibration, is approximately confirmed by the experiments.

(4) The decrease of resistance of alloys to high-frequency vibrations, to be expected on Liebenow's theory, was not with certainty detected with wave-lengths from 14 to 5 metres. E. H. B.

1927. *Theory of Hertzian Oscillations.* **K. R. Johnson.** (Journ. de Physique, 10. pp. 365–374, June, 1901.)—The period of oscillation of Hertz waves depends on the dimensions of the exciter, and the recognised complete theory considers that for a certain spark-gap there is a certain conductibility of the same order as that of the conductor. Cornu, Hagenbach, and Zehnder and Baille have all pointed out difficulties as regards the theory of the spark-gap. Moll has shown long ago that card is pierced only from one side in a spark-gap, and it was only by change in the current of the inductor that the punctures were reversed, and then they were always in one direction. According to Poincaré, photographs indicate that the first spark is the only one, and that this gives the propulsion to the oscillations which follow. In short, all direct experiment is opposed to the view that the gap resistance suddenly falls from, say, 1,000 megohms to 10 ohms, and persists at the low resistance for an appreciable time. The author proceeds to examine the simple electrodynamic theory of the circuits, taking cases when capacity is very great or nil or infinity. He concludes that it is not necessary to have two theories of action (1) for the exciter and (2) for the resonator, and that all theories by which new properties are attributed to the explosive distance are useless. P. E. S.

1928. *Singing Arc-Lamps.* **W. Peukert.** (Elektrotechn. Zeitschr. 22. pp. 467-468, June 6, 1901.)—The author arranged a direct-current arc-lamp with a choking coil, and between the arc and the choking coil he took off a branch in parallel, from carbon to carbon, this branch carrying a condenser and a key. On depressing the key it was found that for a particular length of arc (with a small range of variation), say ¾ mm., the arc sings out a high-pitched note (varying according to the length of the arc). The current in the condenser branch undergoes oscillations whose period is $T = 2\pi\sqrt{CL}$, say 9,000 per second; and the voltage at the condenser is, say, 40 volts. This enables low-pressure alternating currents of extremely high frequency to be obtained. With such currents it is easy to obtain all the results characteristic of high-frequency currents. [*Cf.* Abstracts Nos. 846, 850, and 1234 (1901).]

A. D.

1929. *Electric Oscillations in Metal Rods.* **F. Kiebitz.** (Ann. d. Physik, 5. 4. pp. 872–904, July, 1901.)—The experimental method adopted is like that used by v. Bjerknes, but the author in most of his experiments on intensity of resonance uses a small electrometer with a single moving vane mounted on a quartz fibre.

The conclusions arrived at are :—

1. A rod-oscillator radiates harmonics as well as the fundamental radiations ; the frequencies of the harmonics are odd multiples of the fundamental frequency. The existence of eight such harmonics was verified. Their intensities are very small compared with that of the fundamental.

2. Oscillators of other than rod-forms also radiate *overtones*, but these are not harmonics of the fundamental.

3. The node- and antinode-surfaces of the magnetic force in the neighbourhood of rod-oscillators agree approximately with the theoretical surfaces calculated by Abraham, *i.e.*, they are approximately hyperboloids of revolution having their foci at the outer ends of the rods and centre at the centre of the oscillator.

4. The damping of the oscillations is greater the smaller the distance between transmitting and receiving resonators.

5. In the case of the fundamental vibrations the logarithmic decrement in the receiver was 0·154 at 2 m. distance and for the first harmonic 0·182 at 30 cm. distance from the transmitter. These decrements are correct to 10 or 15 per cent.

6. The cause of the damping arises more from the radiation of energy than from heat lost at the spark in the transmitter.

7. A straight receiver does not give as good a resonance as one of circular form.

8. A coherer may be used to verify resonance, but not with a circular receiver; the straight line receiving resonator must be the same length as the transmitting resonator in this case. The coherer acts either as a conductor or as an insulator of very great capacity. J. B. H.

ELECTRICAL PROPERTIES AND INSTRUMENTS.

1930. *Resistance of Nickel.* **A. Campbell.** (Elect. Rev. 48. pp. 1014–1015, June 14, 1901.)—The author gives curves showing the resistance of two specimens of nickel at different temperatures up to 700° C. Both specimens were commercial, one being bought recently, the other six years ago; their resistivities are respectively 8 and 12 microhm-cms., the former value being near Fleming's figure of 6·9 for pure nickel; the older specimen has a lower temperature coefficient. The two curves show a bend at 300° C. G. H. B.

1931. *Graphic Method for Calculating the Distance of a Break in a Submarine Cable.* **E. Jona.** (Electrician, 47. pp. 333–334, June 21, 1901.)—Calculating by Kennelly's and Schaefer's methods is laborious. The author measures the currents with a Weston galvanometer of 150 ohms resistance with suitable shunts. By altering the resistances inserted in the battery circuit, he finds the currents best adapted to his calculations; further to save time he tests with a series of different currents, plotting the results in a curve in which the abscissæ are resistances, R, and ordinates are values of current, i, through the break. He uses an observation of Kennelly, that the resistance of a break varies inversely as the square root of the current if the latter is under 25 milliamperes. Then $R = x + \frac{Z}{\sqrt{i}}$, where Z is the resistance of the break, according to the false zero method. This equation represents a curve of the third order in R and i. Transforming this curve and bringing the value $1/\sqrt{i} = z$ as ordinate instead of the values of i, the author obtains a straight line, cutting the axis R at a point which indicates the distance of the break. A similar process with the true zero gives a similar result. E. O. W.

1932. *On the Behaviour of Liquids in Capillary Tubes under the Influence of an Electric Current passed through Air.* **S. Lemström.** (Ann. d. Physik, 5. 4. pp. 729–756, July, 1901.)—This paper describes a continuation of certain experiments made by the writer in 1898. In these experiments an influence machine was employed of which one pole was earthed and the other connected with a metallic point above a vertical capillary tube, the lower end of the tube being in a vessel of water, and the water connected electrically to earth. By an electric current passed through air is understood one which passes through a stratum of air of greater or less width. It was found in these experiments that under the influence of this air electric current, water rose along the sides of the tube, and formed drops in the upper end.

In the series of experiments described in this paper a Leyden jar is introduced with its inner coating connected with a zinc plate on which the water-containing glass vessel is placed. The jar is connected with a spark micrometer. Were the tube removed and the machine in action, the jar would be successively charged and discharged. On introducing the tube in the manner described, the sparking is found to increase, which proves that the conductivity of the stratum of air between the metal point and the tube has increased. The phenomenon of the rise of water along the surface of the tube and the formation of drops is observed now to take place, but only when the metal point is connected with the negative pole of the machine.

The writer discusses the different results according to different arrangements of the apparatus. In conclusion, the relation of the phenomena here described to the influence of electricity on plants is discussed with reference to former papers by the author. S. H. B.

1933. *Capacities of Polyphase Cables.* **A. Russell.** (Inst. Elect. Engin., Journ. 30. pp. 1022–1037, June, 1901.)—The author calculates that the capacity of a single-phase cable consisting of two conductors embedded in insulating material is given by—

$$K = \tfrac{1}{2}(k_{11} - k_{12}),$$

where k_{11} is the capacity of one conductor when the other is earthed, and k_{12} is the charge on the same conductor due to unit potential of the other conductor.

For a three-phase cable the author obtains the following result :—

The capacity between 1 and 2, 3, $S = k_{11}$,
" " 1, 2 and 3, $S = 2(k_{11} + k_{12})$,
" " 1, 2, 3 and $S = 3(k_{11} + 2k_{12})$,
" " 1 and $2 = \tfrac{1}{2}(k_{11} - k_{12})$,
" " 1 and 2, $3 = \tfrac{2}{3}(k_{11} - k_{12})$,

where S represents the sheath.

These formulæ are verified by experiment. W. G. R.

1934. *Alternate-current Wattmeter.* **C. V. Drysdale.** (Electrician, 46. pp. 774–778, March 15, 1901; also Électricien, May 4 and 11, 1901.)—The author works out formulæ for correcting wattmeter indications for self-induction and for capacity in the shunt circuit, on the assumption of a sine-wave current; he also discusses the influence of wave-form on wattmeter indications, and how far the corrections calculated for sine-waves are applicable to other wave-forms. The errors due to eddy-currents in metal fittings on the instrument depend on the power-factor of the circuit measured, and on the specific resistance of the metal. With brass fittings the eddy-currents will not lag much more than 90° behind the main current, and will introduce errors in measuring on very inductive circuits; with copper fittings, on the other hand, the lag will be more nearly 180°, and the errors introduced will have most effect at high power-factors. The author deprecates the use of transformers in the shunt circuit of wattmeters, except for measurement on circuits of high power-factor. A wattmeter capable of measuring a power-factor to an accuracy of 0·001 on a 100-volt circuit must have the resistance of its shunt coil at least 628,000 times its self-induction in henrys; pivoted wattmeters cannot fulfil this condition, as they require too large a control, Kelvin watt-balances and direct-reading wattmeters are subject to errors from the mutual induction between the series and shunt coils.

The author then describes fully with illustrations a wattmeter designed by himself; it is given a very large range by the device of winding the two series coils with eight-strand wire, each strand being insulated and connected to mercury cups, so that the 16 circuits can be connected all in parallel or in series or in any combination of the two. G. H. B.

1935. *Alternate-current Wattmeter.* **W. M. Mordey.** (Inst. Elect. Engin., Journ. 30. pp. 387–391, April, 1901.)—The instrument is constructed on the lines of a Siemens' dynamometer, in which the moving coil is replaced by a single turn of wire closed on itself; this forms the secondary of a small transformer, placed below the fixed coil, and swings in the space usually occupied by the secondary winding. The current in this moving coil is induced by the primary winding of the transformer, instead of being led in through mercury cups. If the induction in the transformer wire be sufficiently low, the current in the moving coil is proportional to the e.m.f. on the primary winding. By making the moving coil of manganin or platinoid, variation of the constant due to temperature changes are avoided. Tests at the Board of Trade laboratory show that the scale is proportional throughout; the constant, however, depends on the frequency, varying about 10 per cent. between 30 and 90 ∿. An important advantage is that the primary of the transformer, as well as the fixed current coils, may be variously wound and connected, so that the wattmeter can be made for a large range both of e.m.f. and current.

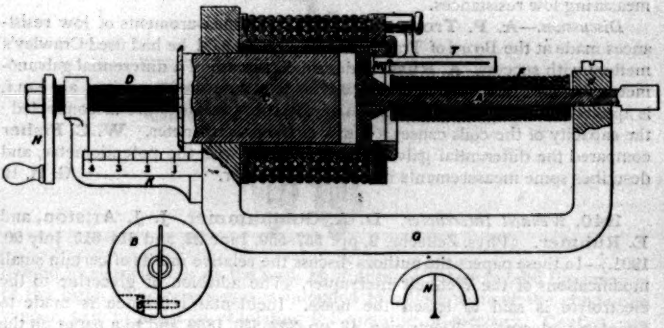
Discussion.—**J. A. Fleming** considered that the wattmeter had the disadvantage, in comparison with the ordinary wattmeter and separate transformer, that no experiments could be made to ascertain exactly the phase-difference between primary e.m.f. and induced current. **G. L. Addenbrooke** thought the wattmeter adapted only to circuits of high power-factor, otherwise magnetic leakage in the transformer would entirely vitiate the readings. G. H. B.

1936. *Alternate-current Wattmeters.* **C. V. Drysdale.** (Electrician, 47. p. 61, May 3, 1901.)—The writer compares the electro-dynamometer wattmeter with Addenbrooke's electrostatic wattmeter [see Abstract No. 1124 (1901)]. The latter has the advantage of being deflectional, and of having quadrants easily adjustable to make it direct reading. The dynamometer, however, requires no projection arrangement, is less delicate and much cheaper. G. H. B.

1937. *Recording Electric Instruments.* **P. Perrin.** (Soc. Int. Élect., Bull. 1. pp. 155–180; Discussion, pp. 180–184 April, 1901.)—This paper is a description of the different recording instruments shown at the Paris Exhibition of 1900. They consist for the most part of ammeters, voltmeters, and wattmeters of ordinary types with recording attachment, and call for no special mention. The clockwork is generally contained in the drum, in some cases revolving with it and in others being fixed. In certain cases provision is made for altering the rate of revolution by interchange of gear-wheels. The record is either a continuous line traced by an ink pen, or, in an instrument by Janet, by a metallic point on an impregnated paper, a current passing through the paper from the point to the drum; or the record is a dotted line produced by periodical contacts between pen and paper. An instrument of a novel type is a recorder devised by Lartigue for the insulation resistance of a network. It consists of a recording voltmeter, with a mercury switch operated periodically by the clockwork, and introducing between the main and earth a resistance of incandescent lamps. The voltmeter has two scales, one reading volts, and the other the current through the resistance; the quotient of the former by the latter gives the insulation resistance of the main including the leak caused by the voltmeter.

Discussion.—**C. Jacquin** described his experiences with recording instruments on tramways and railways. He obtained good results with glycerine dash-pots, as employed in the Richard recorders, and also with the magnetic damping used in the Meylan instruments; the damping in Arnoux and Chauvin's instruments was not sufficiently strong. G. H. B.

1938. *Permeameter.* **C. G. Lamb** and **M. Walker.** (Inst. Elect. Engin., Journ. 30. pp. 930–941; Discussion, pp. 941–944, June, 1901.)—Referring to the figure, the instrument consist of an iron yoke G, whose magnetic circuit is completed by the test-rod A, and an air-gap between the iron disc B and the iron cylinder C. The disc B has a hole to take the test-rod or server as pole-piece; the cylinder C can be moved so as to adjust the length of the air-gap, by a micrometer screw and scale. The test-rod is 7 inches long and ⅜ inch in diameter. The magnetising coils E and F are wound with the same number of turns and connected in series; they act in the same direction, and consequently, if the reluctance of the test-rod and air-gap be equal, the magnetic flux will be uniform. If the reluctances be unequal there will be magnetic leakage at the pole-piece B. The presence of any leakage is shown by a small pivoted needle N, protected from air currents by a tube T with mica windows. The needle is magnetised, and is controlled by a permanent magnet so as to take up a central position when the yoke is demagnetised. To take a reading for any particular magnetising current, the air-gap is adjusted until the needle returns to its central position; the length of air-gap required to give balance can be thus determined to one-thousandth of an inch, and the value of the permeability can be found from the reading of the micrometer screw by means of a calibration curve.



The authors give details of experiments made to determine whether the calibration curve is the same for specimens differing widely in permeability; except for very low inductions, the readings of the instrument were found correct to within 1 per cent. for soft iron and for hard steel.

Discussion.—**Drysdale** suggested that if the yoke were made heavier, and the contacts better, the reluctance might be made negligible, and the instrument rendered independent of calibration. He pointed out that at high permeabilities the air-gap is very small, and therefore that the readings are subject to the greatest error under conditions when generally a high accuracy is required. G. H. B

1939. *Differential Galvanometer.* **C. W. S. Crawley.** (Inst. Elect. Engin., Journ. 30. pp. 908–913; Discussion, pp. 913–926, June, and 1128–1129, Aug., 1901.)—The author winds a differential galvanometer double, without adjusting; in one circuit is inserted resistance to about balance when the two circuits are joined in parallel on a battery; in the other circuit is a slide-wire resistance for exact adjustment and a resistance of about $\frac{1}{1000}$ of the coil resistance, which can be cut out by a key. To compare two coils, they are joined in series with a battery, and their terminals joined to the two galvanometer circuits. If not quite equal a deflection is produced, the value of which can be found by pressing the key, which gives the value for 0·1 per cent. difference. Coils of different values can be compared by adding resistance to balance to one galvanometer circuit. The author then deals with the errors to which the method is subject, and describes a workshop method of measuring low resistances.

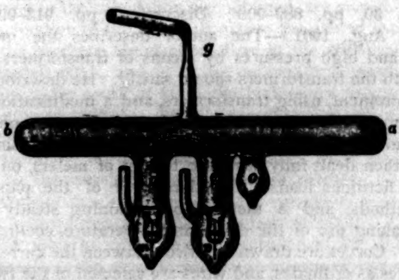
Discussion.—**A. P. Trotter** described some measurements of low resistances made at the Board of Trade Laboratory, and said he had used Crawley's method with success. **A. Russell** described the use of a differential galvanometer for measuring inductances, and as a standard of capacity; an e.m.f. is applied to the two outside terminals, when the two inner are disconnected; the capacity of the coils causes a throw of the galvanometer. **W. C. Fisher** compared the differential galvanometer method with the potentiometer, and describes some measurements made with the latter. G. H. B.

1940. *Wehnelt Interrupter.* **D. A. Goldhammer, J. J. Ariston,** and **E. Ruhmer.** (Phys. Zeitschr. 2. pp. 557–559, June 22, and 614–615, July 20, 1901.)—In these papers the authors discuss the relative merits of certain small modifications of the Wehnelt interrupter. The addition of glycerine to the electrolyte is said to lessen the noise. Incidental reference is made to Swinton's interrupter, Electrician, 43. pp. 332–333, 1899, and to a paper on the subject by A. G. Rossi, Atti R. Acc. delle Scienze Torino, 34, 1899. R. A.

1941. *Induction Coils.* **F. Klingelfuss.** (Ann. d. Physik, 5. 4. pp. 837–871, July, 1901. From the Verh. d. naturf. Gesell. in Basel, vol. xiii.)—An attempt is here made to investigate the working of an induction coil and to find some data which would be useful in designing a coil to fulfil given conditions. Two different kinds of coil are experimented with, one having the ordinary straight core and the other having its magnetic circuit closed except for an air-gap of about 1 cm. The secondary windings are in sections so that the influence of the number of turns in the secondary on the working of the coil can be determined. The inductive e.m.f. in the primary windings on breaking the primary current is determined by means of a spark micrometer in parallel with the primary. The variations of this e.m.f. with the current strength and with the number of turns in the secondary are determined. The influences of the primary current strength, of the capacity of the condenser, and of the number of turns in the secondary windings on the spark-length and also on the nature of the spark are given in tabular form in the paper.

A Carpentier coil to give a 45 cm. spark has 158,000 turns and a resistance of 50,000 ohms, while one constructed to the author's designs to give 100 cm. spark has 86,000 turns and a resistance of 40,000 ohms. [See also Abstract No. 1717 (1901).] J. B. H.

1942. *Mercury Vacuum Lamps for Spectroscopic Work.* **O. Lummer.** (Zeitschr. Instrumentenk. 21. pp. 201–204, July, 1901.)—The author gives details as to his method of constructing mercury lamps, which were first described by Arons (Wied. Ann. 47. p. 767, 1892, and 58. p. 73, 1896). The lamp is intended for use in spectroscopic work, and for producing monochromatic light of considerable intensity. Arons' form was liable to burst if large currents were used; and though, by immersing it in water, this could be avoided, yet the mercury vapour condensed on the walls of the tube, and so dimmed the light. The author's form is shown in the accompanying diagram. The light passes between the mercury electrodes *c* and *d*, and the lamp is immersed in flowing water, the ends *a* and *b* remaining exposed. The tube *ab* is of frosted glass, except over the portion *a*, which is clear. The light is observed either through the end *a* or *b*. In this way the condensed mercury vapour on the walls of *ab* does not interfere with the emission of the light. The reservoir *o* is intended to collect some of the condensed vapour, and to assist in regulating the quantity of mercury. Contacts are made by the mercury cups *m* and *p*. During the act of exhaustion, the tube *ab* should be first held in a vertical and then in a horizontal position, in order to prevent the mercury from occluding gases on the walls of the tube. Various details are given as to the mounting of the lamp as a commercial article. It is supplied by Muencke, of Berlin. A lamp that has been properly exhausted works well for years, and the light is almost entirely free from flickerings. The author works generally with an arc about 3 cm. long, and has a series resistance of 5 ohms with 16 amperes at 110 volts. Even with this current strength the lamp will burn for a considerable time without danger of bursting. [See also Abstract No. 1470 (1899).] W. H. S.



1943. *Synchronism and Frequency Indication.* **P. M. Lincoln.** (Amer. Inst. Elect. Engin., Trans. 18. pp. 435–450, June and July, 1901.)—A phase meter, which with a slight modification becomes also a frequency teller, is described. These instruments have been used by the Niagara Falls Company for synchronisers and recording tachometers with successful results. The phase meter consists of a fixed coil inside which is placed an armature made up of two equal coils at right-angles to one another. One alternating p.d. is applied to the terminals of the fixed coil and the other sends equal currents through the two equal coils of the armature. The currents in the two armature circuits are made to differ in phase by nearly 90 degrees by putting a non-inductive resistance in series with one of them and an inductive coil in series with the other. It is proved that a pointer fixed to the armature indicates directly on an evenly divided scale the phase difference between the two e.m.f.'s. At Niagara the instrument is mounted on a swivel so that it can be made to face the particular dynamo that is to be synchronised. The busbars are connected to the fixed coil and the dynamo to the movable coils. When used as a frequency teller the circuit in series with the fixed coil is adjusted to resonance at the standard frequency. A comparatively small change in the frequency will then introduce a large change in the phase differences and hence the scale of the phase meter can be graduated to read the frequency accurately. A full and clear mathematical discussion is given of the action of the instrument when subjected to e.m.f.'s following the harmonic law. A. R.

1944. *Alternate-current Measurement.* **A. Campbell.** (Inst. Elect. Engin., Journ. 30. pp. 889–908; Discussion, pp. 913–926, June, and pp. 1128–1129, Aug., 1901.)—The author describes the measurement of large currents and high pressures by means of transformers, and gives the conditions which the transformers should satisfy. He describes two methods of power measurement, using transformers, and a modification of the three-voltmeter method; next comes a method of measuring phase-differences close to 180°, and a description of a thermal ammeter using an aneroid chamber. He then deals fully with the testing of meters, on non-inductive, inductive, and fictitious loads. The third part of the paper deals with thermopile methods, and a method of obtaining steady currents and voltages, by making use of the different temperature coefficients of nickel and manganin. Curves are drawn for wires between the currents as abscissæ and the pressures as ordinates, and wires are selected of the two materials so that the curves are parallel over a portion of their length; the vertical distance between them then represents a constant pressure. If a Wheatstone bridge be made up of two nickel and two manganin wires in opposite arms, and a variable current sent through two opposite points, a constant voltage is obtained at the other opposite points. Finally two null methods of measuring currents are described, making use of this Wheatstone bridge arrangement.

Discussion.—**C. V. Drysdale** pointed out various sources of error in the author's methods, more particularly in the use of transformers, and advocated the use of dynamometer wattmeters. **H. L. Callendar** described thermal methods of measurement and of obtaining constant current similar to Campbell's. G. H. B.

1945. *Earth Currents.* **Foerster.** (Elektrotechn. Zeitschr. 22. pp. 331–333, April 11, 1901. Paper read before the Elektrotechn. Verein, Feb. 26, 1901.)—The speaker summarised the results of the German Committee on earth currents, formed in 1881, whose material was collected from 1882 to 1890, and has since been sifted and worked out by Weinstein. The lines used for the investigation were one extending south from Berlin to Dresden, and another running east from Berlin to Thorn. It was found at once that earth currents influence the magnetometer just as a current does in an ordinary galvanometer. The strictly contemporary character of earth-current and magnetic disturbances was so marked that the difference of longitude between Berlin and Wilhelmshafen could be determined within a second by observations of the epoch of a magnetic and an earth-current disturbance respectively. The next question at issue is whether the earth-current generates the magnetic disturbance or the magnetic disturbance induces the earth current. The decision in favour of the former alternative is brought by the fact that the rate of change of the magnetic force does nct influence the intensity of the earth current. The speaker proposed a scheme of international earth-current observations. E. E. F.

1946. *Physical Decomposition of the Earth's Permanent Magnetic Field.* Part II. *The Composition and Characteristics of the Uniform Magnetic Field.* **L. A. Bauer.** (Terrestrial Magnetism, 6. pp. 13–26, May, 1901.)—By the uniform magnetic field of the earth the author means that portion of the earth's permanent magnetic field which can be referred to a uniform homogeneous magnetisation about a single axis (the magnetic axis). In the present paper the author investigates the question as to whether the same value is obtained for the uniform field if the regions from which the magnetic elements employed in the calculation are obtained, are varied. He concludes that: (1) The inclination of the magnetic axis to the axis of rotation is greater for parallels in the Southern Hemisphere than in the Northern Hemisphere. Between the parallels 60° N. and 10° S. the inclination is practically constant, while for parallels to the south of 10° S. the inclination increases at the rate of 0·26° per degree of latitude. (2) The meridional plane in which the axis of uniform magnetisation lies shifts its position almost uniformly to the eastward as we go from the north towards the south. The amount of motion in longitude is on the average 0·5° per degree of latitude. (3) The value of the magnetic moment is a maximum for the equatorial belt and decreases steadily in both hemispheres with departure from the belt. The author puts forward the view that the cause of the displacement for different portions of the earth's surface is the electric currents induced in the earth owing to the fact that it does not rotate about its magnetic axis. W. W.

1947. *Comparison of Magnetometers.* **L. A. Bauer.** (Terrestrial Magnetism, 6. pp. 31–41, May, 1901. Basis of a paper prepared for the Paris Intern. Meteorological Conference, 1900.)—The author has compared a set of the U.S. Coast and Geodetic Survey instruments with those in use in a number of European observatories. The H comparisons were vitiated by the variations in length and shape of a wooden deflection bar owing to changes in the climatic conditions. A comparison of the results for declination and dip with the sets of measurements made by other observers indicates that we are far from possessing sufficient accurate information as to the differences between the standard instruments in use in the various observatories. W. W.

MEDICAL ELECTRICITY.

1948. *Electrical Resistance of the Human Body.* **W. L. Hooper.** (Elect. Rev. N.Y. 38. p. 821, June 29, 1901. Hand-to-hand resistances were measured either with a Wheatstone bridge and one cell or with volt- and amperemeters and accumulators giving up to 125 volts. The resistances observed varied between 20,000 and 40,000 ohms in the first case, and only between

1,000 and 2,000 ohms in the second. It was not a case of tighter gripping with the higher potential, but there seemed to be increased action of the sweating glands. When very rapid determinations were made with another apparatus comprising condensers, the resistances were higher during the first 0·01 or 0·02 second when the glands had not had time to act than afterwards, but the high values of the bridge method were not obtained, and they should not be relied upon. H. B.

REFERENCES.

1949. *Propagation of Electric Force.* **G. Platner.** (Elektrochem. Zeitschr. 7. pp. 241–250, Feb., 1901.)—Maxwell's theory is preferred to the later electron theory, and is then discussed as to its suitability for explaining electric and especially electrolytic phenomena. G. E. A.

1950. *Anticoherers.* **A. Neugschwender.** (Phys. Zeitschr. 2. pp. 550–552, June 15, 1901.) **E. Marx.** (Phys. Zeitschr. 2. pp. 574–575, June 29, 1901.)—A controversy on the action of anticoherers. J. E.-M.

1951. *Tesla Discharge from Points.* **K. v. Wesendonck.** (Phys. Zeitschr. 2. pp. 529–530, June 8, 1901.)—A further note upon the author's experiments as to high-frequency electric oscillations favouring a positive or a negative discharge from points under various conditions. E. H. B.

1952. *Influence of Electrode Surface on Discharge of Electricity.* **K. v. Wesendonck.** (Phys. Zeitschr. 2. pp. 514–518, June 1, 1901.)—In dealing with ionised gases metallic electrodes are used to test their various electrical properties. The present paper is an investigation as to how the state of the surface of the electrodes may influence the observations so obtained. R. S. W.

1953. *Laws of Vibration of a Linear Resonator in a Field of Steady Radiation.* **M. Planck.** (Phys. Zeitschr. 2. pp. 530–534, June 8, 1901.)—A mathematical treatment of the problems involved in the absorption and emission of energy by particles exposed to steady radiation as, for example, from the walls of a chamber maintained at the same temperature. The particles in question are regarded as linear resonators, and the theories of Hertz and others are applied to the case. E. H. B.

1954. *Electric Discharge in a Gaseous Mixture.* **W. Heuse.** (Ann. d. Physik, 5. 3. pp. 670–677, June, 1901.)—A paper on the same lines as that referred to in Abstract No. 1073 (1900).

1955. *Standard Hysteresis Tests for Iron.* (Elektrotechn. Zeitschr. 22. p. 517, June 27, 1901.)—The regulations of the Verband Deutscher Elektrotechniker with regard to the testing of the magnetic properties of sheet iron are here given. An interesting discussion, which is reported in the Elektrotechn. Zeitschr. pp. 766–768, Sept. 12, 1901, took place at the meeting of the Verein at Dresden, where the regulations were considered and adopted. W. H. S.

1956. *Currents and Potentials on Submarine Cables for Sine E.M.F.'s.* **A. C. Crehore.** (Phys. Rev. 12. pp. 340–352, June, 1901.)—This valuable paper treats mathematically the case of a submarine cable with condensers at the ends under the action of a sine E.M.F.; thus differing radically from Kelvin's original work on the cable which applied to a constant E.M.F. only. The problem is freely illustrated by numerical examples and eleven diagrams, eight of which show potential and current curves for various cases. E. H. B.

CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

1957. *Capillary Constants of Organic Liquids.* **P. A. Guye** and **A. Baud.** (Comptes Rendus, 132. pp. 1481–1484, June 17, and 1553–1555, June 24, 1901.)—Measurements of the molecular state of liquids by the method of Eötvös-Ramsay-Shields.

According to the results communicated in the first note phenetol, anisol, ethyl acetate, nitrobenzene, and benzonitrile are non-associating liquids, while metacresol appears to associate as the temperature rises. The latter conclusion is founded on the following results:—

Temp. Interval.	Value of K.
9·0 — 55·4	2·05
55·4 — 98·7	1·55
98·7 — 153·1	1·89

The results communicated in the second note indicate that the *oximes* and *urethanes* must be classed with the alcohols, acids, ketones, and aliphatic nitriles as associating liquids. F. G. D.

1958. *Relation between Boiling-point and Density of Organic Liquids.* **G. G. Longinescu.** (Annal. Scientifiques de l'Univ. de Jassy, 1. pp. 359–370, 1901.)—For compounds of carbon and hydrogen, with or without oxygen, which contain the same number of atoms in the molecule, the absolute boiling-points are proportional to the molecular weights. In the general case, however, the relation is not so simple, being expressed by the equation: $T/T' = M/M' . N/N' . \sqrt{n/n'}$, where T and T′ represent the absolute boiling-points of two organic compounds, M and M′ their molecular weights, N and N′ the respective number of molecules contained in a unit of volume, and n and n' the numbers of atoms in the two molecules. These relations are upheld by the constants of a large number of compounds. T. H. P.

1959. *Catalysis of Detonating Gas by Colloidal Platinum.* **C. Ernst.** (Zeitschr. Phys. Chem. 37. pp. 448–484, June 18, 1901.)—Results are given of a number of measurements of the velocity with which water is produced from a mixture of two volumes of hydrogen and one of oxygen by the action of colloidal platinum solution. The apparatus used is described, and also a method of quickly and completely saturating the small quantity of solution with the gas. It is found that colloidal platinum is capable of causing the formation of a million times its own quantity of water without losing its activity. No ozone or hydrogen peroxide occurs in the products of the action. The amount of gas acted on per unit of time is directly proportional to the absolute quantity of platinum present. With detonating gas itself the catalysis proceeds with a velocity proportional to the concentration of the gas, while in any mixture of hydrogen and oxygen the reaction goes on as if the gas in excess were a mere diluent. The temperature coefficient of the velocity of the reaction is very small, and becomes negative at high temperatures. The retarding or accelerating actions of certain substances on the reaction seems to run parallel to the similar actions of these substances on the catalysis of hydrogen peroxide by colloidal platinum. T. H. P.

1960. *Semi-Permeable Membranes.* **G. Flusin.** (Comptes Rendus, 132. pp. 1110–1112, May 6, 1901.)—Hitherto more attention has been paid to the measurement of osmotic pressure than to the velocity of osmosis. The author looks for relations between those two quantities. The best results were obtained with Pfeffer's method of producing a membrane precipitated upon the internal wall of the porous vessel, the successes being 10 per cent. To measure the rate of osmose, the manometer was replaced by a graduated horizontal tube, and the rate of displacement of the meniscus was found to be constant for twenty-four hours. The rate of osmosis is not, like the osmotic pressure, independent of the area or of the thickness of the membrane. It varies a good deal with the vessel employed. But if, for different vessels, the rates of osmosis V and V′ of two solutions of the same concentration are taken at the same temperature, it is found that V/V′ is constant and equal to the ratio P/P′ of the two corresponding osmotic pressures. The experiments were made on solutions of glucose, saccharose, antipyrine, and urea. The last substance showed irregularities, but these are due to the fact that a cupric ferrocyanide membrane is permeable to urea. E. E. F.

1961. *Diffusion.* **H. T. Brown.** (Nature, 64. pp. 171–174, June 13, and pp. 193–195, June 20, 1901. Discourse delivered at the Royal Institution, March 22.)—Although the views of Boussingault, according to which the carbonic acid of the air gains access to leaves not through the stomates or minute openings in the cuticle and epidermis but through the continuous substance of these latter, have been shown to be erroneous; yet on applying Loschmidt's absolute values of diffusivity of one gas into another to the passage of the extremely dilute carbon dioxide of the air into the leaf stomates, it is found that free diffusion is apparently able to account for only a portion of the gas known to enter the leaf, unless improbable assumptions are made as to the low proportion of carbon dioxide present immediately under the apertures. By experimenting with a series of exactly similar flasks, partially filled with caustic soda so as to produce a steady flow of atmospheric carbon dioxide down their necks, each having its mouth obstructed with a thin disc of metal or celluloid pierced with a single hole of definite size, the author finds that the amounts of carbon dioxide diffusing down the necks of the flasks in a given time are proportional to the diameters of the disc apertures. This diameter law also holds, under certain conditions, for the amount of absorption by, or evaporation from, plain, circular liquid surfaces; if the air above such surfaces is in slight movement the absorption or evaporation is proportional to the area of the disc, but the smaller the discs and the stiller the air the more nearly does proportionality to the diameters hold. The author goes on to consider the case of a disc with a number of holes in it; if the holes are suitably arranged little or no obstruction is offered to the diffusive flow, although the aggregate area of the holes represents but a small fraction of the area of the disc. Experimental confirmation of this is obtained by allowing copper sulphate solution to diffuse down two separate columns of gelatine, one unobstructed while the other has a perforated celluloid film between it and the liquid, or by making a similar experiment with a perforated and a non-perforated septum luted on to short tubes containing caustic soda solution; in one of the author's trials a larger quantity of carbon dioxide is found to diffuse through a perforated disc than through an aperture of area equal to the disc. The author draws an analogy between the absorbing disc or perforation of these diffusion experiments and an electrified disc embedded flush in a wide non-conducting rim; in the latter case the surfaces of equal electric potential in the air above the disc will be represented by a series of hemi-spheroids which in any vertical section passing through the centre of the disc will give a series of ellipses having their common foci in the edges of the disc, the lines or tubes of force consisting of a series of hyperbolæ, also having their foci in the edges of the disc. Such an analogy gives a reasonable and consistent explanation of all the phenomena of diffusion into and through apertures, besides completely explaining the "diameter law" and making possible the accurate prediction of the amount of gas, vapour, or solute passing under given conditions. The existence of zones of equal density in the neighbourhood of an aperture through which diffusion is going on may be shown by means of a rectangular cell divided horizontally by a thin plate of celluloid with a circular hole punched in it, the lower half of the cell being filled with a solution of gelatine containing a little barium chloride and the upper half with sodium sulphate solution; if the relative strengths of the two solutions are so adjusted that the two salts, diffusing in opposite directions, meet in the gelatine, barium sulphate is precipitated at the surfaces of contact of the two streams, the result being a slowly growing, spheroidal mass of precipitate starting from the aperture and resembling in shape the head of an inverted mushroom. By making the diffusion of the sodium sulphate intermittent, or by alternating the diffusion of a sulphate with that of a chromate, well-marked spheroidal zonings are obtained in the precipitate. In a similar manner the form of the zones of equal intensity for diffusion through several apertures or between two parallel plates may be found. Experiment shows that the most efficient arrangement of very small apertures is to have them about 8 or 10 diameters apart, for in this case interference with each other practically ceases; this is generally about the distance apart of the stomates on the underside of most leaves. To account for the passage through the stomates of the quantity of carbon dioxide absorbed by a leaf it is only necessary for the carbon dioxide content of the air just within the leaf to be kept down to 2·8 parts per 10,000, when that of the outer air is 3 parts per 10,000. T. H. P.

1962. *Chemical Reactions in Dissolved or Gaseous Systems.* **Ponsot.** (Comptes Rendus, 132. pp. 1551–1553, June 24, 1901.)—Imagine a solution in which a reversible chemical reaction can occur. Denote the systems on each side of the equation by 1 and 2. Suppose that at constant temperature and pressure, 2 increases indefinitely at the expense of 1 as the dilution increases. Let e denote mass of the solvent and Φ total internal thermodynamic potential. Consider a system not in equilibrium. If 2 tend to *increase*, $\frac{d\Phi}{dm}$ is negative, m denoting the molecular concentration of one of the components of system 2. Equilibrium, corresponding to $\frac{d\Phi}{dm}=0$, will be established by diminishing e. Hence $\frac{\partial}{\partial e}\frac{d\Phi}{dm}$ is negative. Similarly if 2 tends to *diminish*, it can be shown that $\frac{\partial}{\partial e}\frac{d\Phi}{dm}$ is also negative. Hence with the given assumptions it is always negative. But—

$$\frac{\partial}{\partial e}\frac{d\Phi}{dm}=\frac{d}{dm}\frac{\partial\Phi}{\partial e}=v\frac{df}{dm}$$

when f = vapour-pressure of solvent and v the corresponding specific volume. Hence "the formation of the system which tends to exist excluvalues to about N/80, but the values then decrease to 0·381 for N/30, 0·223 for N/12, and 0·003 for N/4 solutions; the value for $CdSO_4$ is constant to N/30, but decreases to 0·254 at N. The values for $CuSO_4$ are very constant to N/16, but decrease to 0·328 in N/4 solution. T. M. L.

1968. *Degree of Ionisation of Strong Electrolytes.* **O. Sackur.** (Zeitschr. Elektrochem. 7. pp. 784–787, July 18, 1901.)—Jahn has explained the deviations of strong electrolytes from Ostwald's law by assuming that the law of mass-action applies for ionisation as well as for the dissociation of gases, but that the migration-velocities of the ions are influenced by the presence in the solution of the strong electrolyte; thus he supposes the mobility of the ions to be 6 per cent. greater in N/100 HCl than in 600 HCl. It is now shown that even if this is true the law of mass-action must break down in the case of mixtures, for the conductivity of mixtures of KCl and HCl, and of KCl and NaCl cannot be calculated from the law of mass-action even when Jahn's values for the migration velocities are assumed. The differences between the observed and calculated values usually amount to 2 or 3 per cent. The views of Hausrath, that the partial pressure of the unionised molecules is increased by the ions in the solution, and of Steinwehr, that the internal pressure of the water is altered by the electrolyte, are also criticised. [See also Abstract No. 1742 (1901).] T. M. L.

1969. *Electrical Test for Small Quantities of Electrolytes whose Ions have different Migration-Velocities.* **M. Oker-Blom.** (Zeitschr. Phys. Chem. 37. pp. 665–672, July 12, 1901.)—Two calomel electrodes, containing 0·01 KCl and 0·00001 KCl, were connected by a strip of filter-paper moistened with an electrolytic solution; a marked e.m.f. was produced, amounting to about 0·1 volt in the case of normal hydrochloric and lactic acids and about 0·04 volt in the case of hydrogen potassium phosphate. By this method a fraction of a milligramme of an electrolyte can be detected, and the method is especially adapted to physiological work. T. M. L.

1970. *Contact E.M.F.'s and the Ionic Theory.* **E. Rothé.** (Comptes Rendus, 132. pp. 1478–1481, June 17, 1901.)—The author has employed a Lippman capillary electrometer, using as liquids dilute sulphuric and dilute hydrochloric acid, keeping the liquid in the neighbourhood of the large mercury surface saturated with mercurous sulphate and mercurous chloride respectively. Varying the strength of the acid solution employed, he has determined the compensating e.m.f. required for maximum surface tension. He finds for dilute solutions a "very satisfactory" agreement between the experimental results and the values calculated on the basis of the Nernst-van't Hoff-Arrhenius theory. F. G. D.

1971. *Liquid Cells.* **O. Sackur.** (Zeitschr. Elektrochem. 7. pp. 781 784, July 18, 1901.)—In the combination—

$$\mathrm{Ag} \mid \mathrm{AgCl} \mid \mathrm{KCl}(c_1) + \mathrm{KNO_3}(\gamma) \mid \mathrm{KCl}(c_2) + \mathrm{KNO_3}(\gamma) \mid \mathrm{AgCl} \mid \mathrm{Ag}$$

$$+\, \mathrm{Ag} \mid \mathrm{AgCl} \mid \mathrm{LiCl}(c_2) + \mathrm{LiNO_3}(\gamma) \mid \mathrm{LiCl}(c_1) + \mathrm{LiNO_3}(\gamma) \mid \mathrm{AgCl} \mid \mathrm{Ag},$$

all the e.m.f.'s are balanced except those at the boundaries of two lithium and of the two potassium solutions; as the migration velocities of the $\overset{+}{\mathrm{K}}$ and $\overset{-}{\mathrm{Cl}}$ ions are nearly equal the e.m.f. between the two potassium solutions is negligible, and the e.m.f. of the combination is simply that which is set up between the two lithium solutions, $LiCl(c_1)$ and $LiNO_3(\gamma)$ and $LiCl(c_2)+LiNO_3(\gamma)$. Abegg and Bose (Zeitschr. Phys. Chem. 30, 545) have given for the e.m.f. between two solutions of this kind a general formula of which Nernst's formula is a particular case ($\gamma=0$), and this formula has now been tested by means of combinations of the type given above in the case of dilute solutions of lithium chloride containing equal amounts of lithium nitrate, and dilute solutions of hydrochloric acid containing equal amounts of nitric acid. The concentration of the more dilute chloride solution was in all cases N/500, whilst the less dilute chloride solution varied from N/25 to N/100 in the different experiments; the concentration of the nitrate in the solutions varied from N/25 to N/200. The observed e.m.f. varied in the case of the lithium solutions from 0·0024 to 0·0128 volt and in the case of the acid solutions from 0·0038 to 0·0296 volt; the values calculated from the formula of Abegg and Bose agree very closely with the observed values, and in only three cases was a difference greater than 0·001 volt observed. T. M. L.

1972. *Action of Non-electrolytes on the Hydrolysis of Ethyl Acetate.* **C. Kullgren.** (Zeitschr. Phys. Chem. 37. pp. 613–622, June 28, 1901.)—The reaction-constant for the hydrolysis of N/40 ethyl acetate by N/40 sodium hydroxide at 20·7° is 4·04. It is reduced to 3·16 by the addition of 5·3 gm. cane-sugar per litre (= N/40), to 1·96 by the addition of 21·1 gm. per litre (= N/10) and to 0·38 by the addition of 158·7 gm. per litre (= 3/4N). This very marked effect is probably due to the partial neutralisation of the sodium hydroxide with formation of a saccharate. The addition of glycerol produces a similar, though smaller effect, the constant being reduced to 2·74 by the addition of 162·3 gm. of glycerol per litre (= 2·3N), and to 1·64 by the addition of 325·7 gm. per litre (= 4·6N). The addition of methyl alcohol, ethyl alcohol, and acetone also causes a diminution of the reaction-constant, but the effect is not very great except when these substances are added in large excess; it is probable that they act chiefly by altering the medium in which the interaction takes place, and not by combining with the base.

The addition of non-electrolytes causes a diminution in the conductivity of N/40 sodium hydroxide, which is comparable with the diminution of the reaction-constants. T. M. L.

1973. *Electrochemical Action.* **C. J. Reed.** (Frank. Inst., Journ. 151. pp. 369–393, May; 401–413, June; and 152. pp. 46–58, July, 1901.)—General considerations of voltaic action and electrolysis. The author upholds the theory according to which the ions receive induced charges when a p.d. is applied to the electrodes, and separate only when this p.d. exceeds a certain value. He suggests that concentration changes are due to the rotation of the molecules. W. R. C.

1974. *Accumulator Short-Circuit Diagrams.* **M. U. Schoop.** (Centralblatt für Accumulatoren, 2. pp. 157–160, June 1, 1901.)—The discharge of an accumulator is studied by taking the e.m.f. on open circuit as the cell is gradually short-circuited. The corresponding current is also observed, and the results are plotted to obtain a "short-circuit diagram." The examples given show that the e.m.f. is a simple linear function of the current strength. The charge at each plate is also observed by the help of an intermediate electrode of mercurous sulphate. The fall of pressure is by this means shown to be greater at the lead than at the peroxide plate. W. W. H. G.

1975. *Theory of Accumulators.* **E. Abel.** (Zeitschr. Elektrochem. 7. pp. 731–738, June 27, 1901.)—Of the two views as to the osmotic action of an accumulator, that of Liebenow, which regards the peroxide electrode as reversible with respect to PbO_2 ions, is usually considered the simpler and more readily expressed by exact formulæ. The author shows, however, that Le Blanc's older view of the process is equally satisfactory and leads to the formula—

$$E = \frac{RT}{2} \ln \frac{[Pb'''']_1}{[Pb'''']_2}$$

for the e.m.f. of the cell, $[Pb'''']_1$ being the concentration of the Pb'''' ions at the positive electrode, and $[Pb'''']_2$ the concentration of the Pb'''' ions in equilibrium with Pb'' ions in the presence of lead. N. L.

1976. *E.M.F. due to Magnetisation of an Electrode.* **R. Paillot.** (Comptes Rendus, 132. pp. 1318–1320, June 3, 1901.)—This is a continuation of the researches referred to in Abstract No. 668 (1901). The e.m.f. of soft iron increases with the temperature, and its variation with the temperature is greater the stronger the field. The e.m.f. of bismuth falls but very slowly when the temperature is raised. A. D.

1977. *Effect of Gravity and Pressure on Electrolytic Action.* **R. R. Ramsey.** (Phys. Rev. 13. pp. 1–30, July, 1901.)—Owing to the difference in weight of the ions and their different migration velocities, a small e.m.f. should be set up between two metallic electrodes at different heights in an electrolytic solution. In order to observe this experimentally a tube containing two electrodes of zinc or cadmium amalgam, was filled with zinc or cadmium sulphate and connected in series with a sensitive galvanometer; on raising the tube from a horizontal to a vertical position a deflection of the galvanometer was produced; for purposes of observation the tube was reversed in unison with the swing of the galvanometer until a maximum amplitude of oscillation was produced; from the observed amplitude and the constants of the galvanometer the e.m.f. in the tube could be determined. In the case of zinc electrodes in 10 per cent. zinc sulphate solution the calculated e.m.f. was $2{\cdot}4 \times 10^{-8}$ volts per cm. of height between the electrodes; the values of the e.m.f. observed on six different days were 6·5, 3·9, 2·3, 3·0, 3·4, and $3{\cdot}1 \times 10^{-8}$ volts, the mean of the last five observations being $3{\cdot}1 \times 10^{-8}$ volts. Similar results were obtained with cadmium electrodes in a solution of cadmium sulphate.

The effect of pressure, applied by means of a piesometer filled with kerosene, on a number of cells was also determined, with the following results:—

			Increase of e.m.f. per atmo.	
	E.M.F.	Temp.	(to 100 atmo.)	(from 100 to 300 atmo).
Cadmium	1·019	19°	$7{\cdot}6 \times 10^{-6}$ volts	$7{\cdot}6 \times 10^{-6}$ volts
Clark	1·440	16·6	11·6	11·6
Carhart-Clark	1·443	16·3	13·1	13·1
One-volt calomel	0·996	15	3	0·98
Saturated calomel	0·805	17	2·8	1·63
Copper sulphate	1·078	17	−1 (?)	−1 (?)
AgCl (white)	1·076	18	25·7	15
AgCl (black)	1·164	15·6	—	−13

The pressure-effect is exactly linear in the case of the Cadmium, Clark, and Carhart-Clark cells. T. M. L.

1978. *Solution for Copper Voltameter.* **W. K Shepard.** (Amer. Journ. Sci. 12. pp. 49-56, July, 1901.)—The author used a solution of copper sulphate made as follows:—A saturated solution of copper sulphate was boiled for a short time to expel the air and then kept at 100° C. for about an hour in contact with metallic copper in order to neutralise the solution. The density was then about 1·20. A very small amount of NH_4Cl was added, about 0·05 per cent.

This solution was compared with those due to Grey (Phil. Mag., 1886), and Oettel (Chemische Zeitung, 1893). The former can be used up to a current density of 0·2 amp. per sq. cm., and the same limit was here found for the latter. No oxidation was found with the present solution up to 0·07 amp. per sq. cm. (the highest attempted), and the result was found to be independent of the current density. If this is 0·05 amp. or more per sq. cm. the solution heats a little, and should be warmed to 35° or 40° C. before passing the current; the result is then satisfactory. The solution may be used a large number of times. W. R. C.

1979. *Electrochemical Production of Alkali Ferrates.* **W. Pick.** (Zeitschr Elektrochem. 7. pp. 713–724, June 20, 1901.)—This paper contains an account of experiments in extension of those of F. Haber [Abstract No. 1364 (1901)] on the electrolysis of caustic alkalis between iron electrodes. All varieties of iron undergo anodic polarisation in concentrated alkaline solutions and furnish a variable quantity of alkali ferrate, the largest yield being given by cast iron and the least by wrought iron; steel occupies an intermediate position. Pieces of steel or wrought iron which at first yield no ferrate may always be made to do so by a few seconds' alternate anodic and kathodic polarisation, or by feeble anodic polarisation for a long time in strong alkali. Iron from which ferrate has been produced acquires a dark colour, assumes a passive condition, and resists the rusting action of the air. The yield of ferrate is greater from caustic soda than from caustic potash, and increases with the concentration. Thus, with a current density of 0·1 ampere per sq. dm. in caustic soda, cast iron gave 47 per cent., steel 26 per cent., and wrought iron 14 per cent. of ferrate, whilst in potash the corresponding figures were 37, 13, and 2 per cent. A rise of temperature favours the production of ferrate, the yield in one experiment being almost nil at 0°, 16 per cent. at 30°, and 80–100 per cent. at 70°. The yields of ferrate and of oxygen together amount to 100 per cent.; hence *ferrites* are not formed by a primary electrochemical reaction. N. L.

1980. *Electrochemical Behaviour of Nickel Ammonium Sulphate.* **W. Pfanhauser.** (Zeitschr. Elektrochem. 7. pp. 698–710, June 13, 1901.)—The consistence of electrolytic nickel depends greatly on the chemical composition of the solution from which the metal is deposited, and experience has shown the necessity of using compound salts of nickel rather than simple salts. The present paper describes a large number of experiments on the influence of ammonium sulphate on the electrolysis of nickel sulphate solution. The addition of the former salt causes the formation of the double salt $(NH_4)_2 Ni(SO_4)_2 + 6H_2O$ and increases the specific conductivity of the solution. In concentrated solutions the double salt is dissociated into the ions $\overset{+}{N}H_4$ $\overset{+}{N}H_4$ and $\overset{-}{N}i(\overset{-}{S}o_4)_2$, whilst in dilute solution it undergoes decomposition into its constituent salts. Hence if the electrolyte is not kept stirred, the double salt diminishes and decomposes at the kathode, whilst at the anode it remains undecomposed and often crystallises out. Polarisation occurs at the anode in consequence of the oxidation of nickelous to nickelic sulphate ; the latter salt, however, is unstable and is hydrolysed in neutral solution with the formation of a black deposit of the hydroxide $Ni(OH)_3$. In acid solution this is prevented, and oxygen is evolved. With low current-densities the deposition of the metal is wholly a secondary reaction, but with high densities the double salt is used up faster than it can be replaced by diffusion, the concentration diminishes, nickel sulphate is formed by the consequent decomposition of the double salt, and primary deposition of the metal in a black, pulverulent form occurs. N. L.

1981. *Simultaneous Deposition of Iron and Nickel from Mixed Solutions of their Sulphates.* **F. W. Küster.** (Zeitschr. Elektrochem. 7. pp. 688–692, June 6, 1901.)—Under similar conditions, the electro-deposition of nickel from nickel sulphate takes place at a lower potential than that required for the deposition of iron from iron sulphate, whilst iron is more readily deposited than zinc. Nevertheless, according to Toepffer [Abstract No. 1124 (1900)], when a solution containing the sulphates of iron and nickel, or zinc and iron, is electrolysed the less noble metal is obtained in larger quantity. The experiments previously described by the author [Abstract No. 421 (1901)] have been extended with the object of explaining this anomaly which appears to depend on the relation of the velocity of the reaction to chemical resistance. N. L.

1982. *Action of Ammonium Nitrate Solution on an Iron Kathode. A new Ferroso-ferric Oxide.* **A. Kaufmann.** (Zeitschr. Elektrochem. 7. pp. 733–741, June 27, 1901.)—It has been noticed by Haber and Reininger that when a saturated solution of ammonium nitrate is electrolysed between a carbon anode and an iron kathode, using a kathode current density of about 0·02 ampere per sq. dm., a golden yellow ammoniacal solution is obtained which, when boiled, deposits a bluish-black precipitate. The author has investigated this reaction and finds that the yellow solution, which may also be obtained by the action of ammoniacal ammonium nitrate solution on finely divided iron, contains ferrous ammonium nitrate, whilst the black precipitate consists of a new oxide of iron of the composition Fe_8O_{11}. N. L.

1983. *Electrolytic Reduction of Aromatic Nitro-compounds to Amines.* **A. Chilesotti.** (Zeitschr. Elektrochem. 7. pp. 768–773, July 11, 1901.)—The electrolytic reduction of nitro-derivatives to amines is greatly facilitated, according to previous observers, by the presence of small quantities of tin, copper, mercury, or iron salts. The author describes experiments with nitrobenzene and similar compounds which show the great value of this suggestion. It appears that when copper or iron salts are used, the reduction to hydroxylamine derivatives is effected electrolytically with the simultaneous formation of spongy copper or ferrous salts ; the purely chemical action of these latter then completes the reduction to amines. N. L.

REFERENCE.

1984. *Electromotive Behaviour of Substances with Several Degrees of Oxidation.* **E. Abel.** (Zeitschr. Phys. Chem. 37. pp. 623–625, June 28, 1901.)—A criticism of R. Luther's paper [Abstract No. 1356 (1901)]. T. M. L.

STEAM PLANT, GAS AND OIL ENGINES.

STEAM PLANT.

1985. *Condensing Engines for Lighting Stations.* **R. V. Picou.** (Ind. Élect. 10. pp. 269–271, June 25, 1901.)—The advantage of using condensing engines for electric light central stations is largely a question of the period of working under full load, because the cost of condensing may, under certain circumstances, exceed that of the extra fuel required in non-condensing engines. Condensing may answer in an engine which works all day, but might be useless in one working at maximum load for an hour only. The limits of usefulness are fixed by the local conditions determining the period of full load for each unit.

Failing more recent trials the results of experiments made in 1884 with a Corliss engine at Creusot and published by Delafond in the *Annales des Mines*, Sept. and Oct., 1884, are quoted. In these trials the amount of steam used per h.p.-hour (French) was for—

	With Condensation.	Without Condensation
Indicated h.p.	7·58	9 92
Effective „	9·47	11·41

for powers varying from 122 to 240 h.p. (French).

These figures disclose an important relation called the "organic yield," thus:—

$$\frac{7{\cdot}58}{9{\cdot}47} = 0{\cdot}80, \text{and} \frac{9{\cdot}92}{11{\cdot}41} = 0{\cdot}87.$$

The difference shows the cost (in motive power) of working the air-pump, which in this case was in tandem with the steam cylinder.

With condensers it is usually necessary to lift the requisite water, either first from a well or afterwards to force it through a refrigerator, and the work of the circulating pump must therefore be added. The condensing water amounts to about 200 litres per h.p.-hour, and if we call the lift 10 metres, that means for each h.p.-hour 2,000 kilogrammetres for water lifted or for 150 h.p. 300,000 kilogrammetres or 1·11 h.p. (French). The inefficiency of pumps and loss in transmission of power cause at least 2 h.p. effective to be absorbed.

The comparative economy of steam due to condensation is thus stated :—

	With Condensation.	Without Condensation.
H.P. Indicated	150	150
„ Effective	120	130
„ Disposable	118	
Steam used in kilogrammes per hr....	1137	1488
„ per h.p.-hr. disposable (kg.)	9·63	11·45

Difference in steam used is 1·82 kilog. per h.p.-hr. disposable.

There are, however, additional charges which have to be placed against this economy, such as cost of condenser, pipes and valves, extra foundations, &c. These are taken at 5,500 francs, on which 10 per cent. for interest and sinking fund are charged.

From these figures a commercial equation is found which will give in terms of the value of the fuel the limits of the working period for which condensation will be profitable.

Calling P the price of the fuel per kilogramme, t the annual period of working in hours, and 7·5 the weight of water evaporated per unit of fuel burned, then the cost of surplus steam used in non-condensing engines will be :—

$$\frac{130 \times 1{\cdot}82}{7{\cdot}5} \times \mathrm{P} \times t$$

In the other case, with 550 francs as the annual charge due to the condenser, we find—

$$t \times \mathrm{P} = \frac{550 \times 7{\cdot}5}{130 \times 1{\cdot}82} = 17{\cdot}43.$$

Whence according to different prices of fuel we have the following values :—

P	t
20 francs per ton (French)	871 hours per annum
25 „ „ „	700 „ „
30 „ „ „	580 „ „

Thus even with dear coal it does not pay to condense if the working load is carried for less than 580 hours per annum, or about 1½ hours per day; and with coal at 25 francs the limit is 700 hours, or about 2 hours per day.

With independent condensers the conditions are altered to the extent that the difference in amount of steam consumed is 2 kilogs. ; the cost of installation is 16,500 francs, and the annual charge is 1,650 francs : so that $t\mathrm{P} = 17{\cdot}60$, from which the following values are deduced :—

P	t
20 francs per ton	2,380 hours annually
25 „ „	1,904 „ „
30 „ „	1,517 „ „

Showing no economy with condensation for a less period than 4 to 6 hours per day according to the price of coal.

Even although non-condensing engines may use 16 to 20 per cent. more steam than condensing engines it does not follow that boilers must be increased in size for them, because that is balanced by the use of hotter feed-water. Non-condensing engines enable feed-water at 100° C. to be used, whereas condensing engines do not supply water hotter than 40° C. The difference in evaporation caused thereby is equal to 15 per cent. increase of heating surface. The condenser being often a cause of stoppage from leakage of air, bad joints, pumps, &c., the simpler non-condensing plant would seem to be the more suitable for electric light station work. Ejector condensers are, however, more simple and less costly, although less efficient, than the others.

F. J. R.

1986. *Steam Turbine.* **J. A. Ewing.** (Electrician, 47. pp. 254–256, June 7, 1901.)—A report on trials of a 500-kw. steam turbo-alternator at the works of the Cambridge Electricity Supply Company. The machine was loaded for the purpose of the tests by allowing current to flow between iron plates in the river Cam, the output being measured by means of a Kelvin watt balance. The air-pump discharge was measured by means of two calibrated tanks, used alternately.

Number of trial	1	2	3	4	A	B
Output kw.	518	586	273¼	160½	585	300
Speed r.p.m.	2,670	2,740	2,630	2,590	2,880	2,800
Air-pump discharge } lbs. per kw.-hour	25·0	24·4	28·3	33·1	25·0	27·6

These figures give most satisfactory evidence that the machine working under the conditions of everyday use, and after having been in everyday use for a year, retains its character as a highly efficient electrical generator. H. R. C.

1987. *Transmission of Heat through Scale-covered Boiler Tubes.* **E. C. Schmidt.** (Railroad Gazette, 33. pp. 408–409, June 14, 1901.)—A number of tests of the relative heat conductivity of clean and scale-covered locomotive boiler tubes (the first of a projected larger series of such tests) have been made by F. L. McCune, under the direction of the Railroad Mechanical Engineering Department of the University of Illinois. The tubes were in all cases 1·75 inches diameter inside, and 2 inches diameter outside—the length of tubes is not stated—and were covered with mud scales or mineral scales of various thicknesses, the average ranging from 0·018 to 0·13 inch, and the quality from "soft, porous" to "hard, dense." Each tube was placed in a cylindrical chamber through which water from a constant-pressure tank was allowed to flow, the temperatures at inlet and outlet being observed. The hot gases were passed through the inside of the tube from a combustion chamber in which was a gas-burner supplied with gas and air under regulated pressure. An average of ten experiments gave a gas consumption of 125·6 cubic feet per hour, and an air consumption of 842 cubic feet per hour—the air having been supplied to the burner at a pressure of 5⅜ inches of water.

The temperature of the combustion chamber at the entrance end of the tube was measured by a copper ball pyrometer, and that of the escaping gases by a thermometer.

The difference between the average temperature of the gases and that of the water averaged 869·3° F., and the number of B.Th.U. transmitted during one hour varied from 24859 to 29792 in the coated tubes, the clean tube having transmitted 29854, so that the amount of the decrease in conductivity due to the scales ranged from 0·21 to 16·78 per cent.

The accumulation of additional results is expected to throw light upon the effects of different sorts of scale, so that some general conclusion may be arrived at as to the relations existing between conductivity and the thickness, hardness, and other physical and chemical qualities of the scale. F. J. R.

1988. *Boiler Tests with Illinois Coals.* **L. P. Breckenridge.** (West. Soc. Engin., Journ. 6. pp. 220–230; Discussion, pp. 230–244, June, 1901.)—This is a record of 150 tests carried out by the Department of Mechanical Engineering at the University of Illinois during the last seven years, principally at the power plants of the University, with some at Champaign and Urbana cities. The results are given in tabular form, along with tables of chemical analyses of 68 specimens of Illinois coals and of 57 different specimens of boiler waters, these analyses having been made under the direction of S. W. Parr at the

Department of Applied Chemistry. The coal supplies were from mines scattered over a large portion of the State. The tests were carried out with different kinds of boilers and boiler settings, divided over 8 different plants, those employed having been Stirling water-tube boiler, 1 setting; National water-tube boiler, 1 setting; Babcock-Wilcox water-tube boiler, 8 settings; horizontal tubular boiler, 10 settings. One Murphy smokeless furnace, one Brightman stoker, two Roney automatic stokers, and one Babcock-Wilcox chain-grate stoker were amongst these settings, the remainder having been arranged for hand-firing. Illustrations showing the construction of several of these boilers and settings are given in the paper. The results are more correctly records of everyday performances of these boilers under ordinary conditions, as they were not special tests made to demonstrate the peculiar merits of any special apparatus. Hence they have a value of their own.

The author maintains that whilst a draught of $\frac{3}{16}$ to $\frac{5}{8}$ inch of water gives excellent results with coals having 60 per cent. of fixed carbon, it is found that for most of the Illinois coals a draught of $\frac{6}{16}$ to 1 inch should be provided in order to obtain the best results. He also advocates larger combustion chambers than are customary, and the construction of firebrick arches to prevent the gases coming in contact with the boiler heating surface before inflammation is complete.

Discussion.—**A. Bement** pointed out that the curve of maximum results showed that the highest efficiency was obtained with an evaporation of 2 to 3·5 lbs. of water per square foot of heating surface, the efficiency falling off when that was increased. He had, however, seen instances of an increase of evaporation up to 10 and 11 lbs. of water per square foot of heating surface with concurrent increase of efficiency. He advocated the employment of gas of standard composition burned with minimum air supply for making reliable tests of boiler efficiency of which none had as yet been made. He showed curves of results from Wm. Kent's "Steam Boiler Economy," and from vol. ii. of Jour. West. Soc. Eng., with others in order to compare their relative efficiencies. **Gasche** advocated the formation of a curve of evaporation for each boiler for a given fuel, according to the plan given by him in a paper to the West. Soc. Eng. in August, 1897. **Rice** showed that the methods of estimating moisture in coal are not reliable, so that it is futile to estimate evaporative performance on a basis of "dry coal." **J. J. Merrill** said that he had discontinued the use of 9 boilers in a plant of 20 boilers formerly all in use, and had obtained a reduction of 75 tons of coal per day for the same boiler load. This result was due to analysing the gases and having intelligent firemen. With a new plant fitted with chain-grate stokers burning 52 lbs. of coal per square foot of grate he had, for the same amount of work, a reduction of 55 tons of coal per day as compared with former plant which had about 30 per cent. more heating surface. **Breckenridge,** in reply, referred to the curves of calculated efficiencies for different rates of driving, and of the effect of radiation on efficiency, published in Kent's "Steam Boiler Economy," and also to Kent's formula for the efficiency of a boiler and furnace, which is as follows:—

$$\frac{\mathrm{E}a}{\mathrm{E}p}=\frac{\mathrm{K}-tcf}{\mathrm{K}(1+\mathrm{R}\,\mathrm{s})}-\frac{966\,ac^2f^2}{\mathrm{K}(\mathrm{K}-tcf)}\,\frac{\mathrm{W}}{\mathrm{S}}$$

in which $\mathrm{E}a$ = actual evaporation per lb. of fuel; $\mathrm{E}p$ = possible; K = heating value of fuel per lb. of combustible; $\frac{\mathrm{W}}{\mathrm{S}}$ = evaporation per square foot of heating surface per hour; t = excess of the temperature of the water in boiler

above atmospheric temperature; c = specific heat of escaping gases considered as a constant; f = weight of gases per lb. of fuel; R = radiation per square foot of heating surface per hour; W = water actually evaporated, in lbs. per hour reduced to equivalent evaporation from and at 212° F.; S = area of heating surface in square feet; a = a coefficient of resistance to transmission of heat and of other elements of inefficiency—most easily expressed by $a = \frac{A(T - t)}{cf}$, the numerical value of which lies between $a = 100$ and $a = 400$.
F. J. R.

1989. *Method of Determining Condition of Combustion.* **A. Bement.** (West. Soc. Engin., Journ. 6. pp. 204–217; Discussion, pp. 217–219, June, 1901.)—This paper contains the records of a number of determinations of the amounts of CO_2 and CO, with some of the oxygen also, found in furnace gases, these results being plotted as curves in fourteen diagrams. The determinations were made by means of Arndt's absorber and Arndt's gas-weighing econometer. The first instrument acts by chemical absorption, the gases being drawn from the flue by a small rubber hand-pump and thereafter exposed to the reagent in a simple manner, its maximum speed of operation being determinations at intervals of 30 seconds. In the second instrument a moving stream of gas is weighed by a delicate balance enclosed in an iron case with plate-glass front, the percentages being indicated by a pointer moving over a graduated scale. This instrument is automatic and continuous in its action and can be connected by pipes to several furnaces, the records being shown at a convenient point.

The theoretical maximum amount of CO_2 possible in the gases is assumed at 18 to 20 per cent. of their volume. If CO_2 existed alone in the gases its determination would be simple and its amount, compared with the theoretical maximum, would form a ready index of the condition of combustion. The presence of CO, however, complicates the matter, and the determination of its amount is needed to show whether the combustion has been influenced by excess of air or by incomplete combustion. Chemical analysis of the gases requires time for the determination first of the CO_2, then of the oxygen, and finally of the CO. It is maintained that the Arndt apparatus enables the volume of CO_2 to be compared with the prevailing conditions of the furnace during combustion. It is pointed out that CO_2 increases with reduced air supply or increased coal supply, showing that the air has been in excess of requirements. If it increases after increased air supply, that shows that incomplete combustion has prevailed. The formation of CO is usually due to insufficient air supply, but a case is quoted of increased volume of CO with a larger air supply. Incomplete combustion is due to irregular conditions with sufficient air as well as to deficient air supply. An accumulation of ash and clinker on the grate, or irregular firing, may account for its appearance under the former conditions. Thirteen per cent. CO_2 by volume is given as a common result with the less efficient kinds of furnaces, fluctuations being produced by the operations of stoking and slicing the grate. Examples of records from both instruments are given from furnaces with coal-dust fuel, hand-stoking good and bad, and mechanical stokers of various kinds with and without the necessary supplementary hand work.

In the discussion **Breckenridge** stated that if the CO_2 increases, the supply of oxygen must also increase. The econometer is in use at Illinois University and is found useful and very instructive to those who take an interest in it, whilst firemen can be made to understand that the pointer should be kept at 12 to 14 per cent. in order that they may have the furnaces in the best condition. Replying to Professor Kerr, **A. Bement** stated that an irregular condition of the fire prevented the amount of CO_2 being maintained at the maximum, and instanced the diagram of results on two different occasions with the same chain-grate stoker, coal, and draught. In one case 17 per cent. CO_2 was maintained almost constantly, whilst in the other the percentage was first 5·5, then 7 in ten minutes later, 17 in twenty minutes, back to 9·5 in thirty minutes, at 14·5 in forty minutes, and at 11 in fifty-five minutes, these variations being caused by the method of using the fuel. F. J. R.

AUTOMOBILISM.[1]

1990. *Wilson and Pilcher Petrol Car.* (Automotor Journal, 5. pp. 449–451, June, 1901.)—A description of an experimental vehicle which has undergone extensive trials with success, and which possesses the special merit of being almost entirely free from noise and vibration. The engine is mounted near the front of the car frame, with its crank-shaft in the longitudinal direction. It has four horizontal cylinders, 3-inch bore by 3-inch stroke, mounted on opposite sides of an oil-tight crank chamber. The cranks are arranged in two pairs at 180°. This engine develops 5 b.h.p. at 1,000 r.p.m. The transmission gear between crank-shaft and live rear axle is entirely protected from dust and dirt by means of suitable casings. The change-speed gear is of the combined epicyclic and clutch kind, in which the whole mechanism revolves as one piece for the high speed, and for the low speed the power is transmitted through an epicyclic train of wheels. Two of these gears, each giving two speeds, are employed. They are arranged so that the power may be transmitted through one epicyclic gear only, or through the two coupled in series, and thence through a bevel drive and differential gear, to the live rear axle. Four speeds of 4·5, 7, 13 and 19 miles per hour at 1,000 revolutions of the engine are thus obtained. The reversing gear is formed by the use of two bevel wheels on the exterior of the differential gear box, either of which may be brought into engagement with the bevel pinion from the change-speed gear. The greater part of the weight of the driving mechanism comes direct on to the rear axle, the rear springs carrying only the weight of the carriage body and passengers. The steering of the car is on the Ackermann principle ; it is controlled by a hand-wheel acting through a pinion and quadrant. The road wheels have tangent steel spokes, and are 32 inches diameter front, and 40 inches diameter back. The wheel base is 6 ft. 3 in., and gauge 4 ft. 8½ in. C. R. D'E.

1991. *Trials of Motor Cars.* **W. A. T. Müller.** (Centralblatt Accumulatoren, 2. pp. 177–179, June 15, 1901.)—Hitherto, the few trials that there have been of motor cars have done nothing more than suggest improvements in manufacture, and have not increased our knowledge of the theoretical basis of calculation and construction. In June this year, the German Automobile Club organised trials in which for the first time theoretical considerations were to determine success. For each vehicle entered, the total loaded weight and the power of the motor had to be stated, and the winning vehicle was to be that whose speed most nearly approached the theoretical value calculated by a fixed formula from these data together with measured dimensions, &c. Though only petrol cars could compete, it is instructive to consider the general application of the results.

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[1] Electric Automobiles are described in the Section dealing with Electric Traction.

A formula for the "theoretical speed" in km. per hour is worked out, viz.:—

$$V = \frac{270\pi}{36000} \cdot \frac{D^2Hz}{Q} \cdot \frac{\eta_1 p_m n}{c},$$

Where D = cylinder diameter in cm., H = length of stroke in m., z = number of cylinders, n = revs. per min., p_m = mean cylinder pressure in kg. per sq. cm., η_1 = efficiency of the motor, Q = weight of vehicle in tons, c = traction coefficient in kg. per ton. In this formula the first two members are unalterable and definitely measurable for any vehicle: the third is the uncertain factor, and arbitrary values cannot fairly be given to it. It is therefore better to write—

$$c = \frac{1}{16} \cdot \frac{D^2Hz}{Q} \cdot \frac{x}{R} \eta_1 \eta_2 p_m,$$

Where R = radius of driven wheels, x = reciprocal of the gear ratio, η_2 = efficiency of the transmission gear.

If $\eta_1 \cdot \eta_2 = 1$, the only doubtful factor in the formula is p_m, for which an average value may be reasonably assumed. Then since the best vehicle is that which goes fastest with least expenditure of energy, the order of merit is determined by the smallness of $\frac{c}{V_e}$ where V_e is the observed speed.

E. H. C.-H.

1992. *Liverpool Trials of Motor Vehicles for Heavy Traffic.* (Automotor Journal, 5. pp. 419–441, June, 1901.)—A full description with numerous illustrations is given of the trials carried out by the Self-Propelled Traffic Association in June, 1901. A table is given of their leading dimensions, &c., and also one of hill-climbing tests.

The following table gives a summary of four days' run, showing relative consumptions, &c. :—

TOTAL DISTANCE EQUALS 168 MILES. AVERAGE PER DAY, 42 MILES.

Official Number of Car.	Total useful Ton-Miles.	Total Fuel Consumption.			Total Water Consumption.	Average Speed throughout per Hour.	Average Cost of Fuel per Day.		Average Cost of Fuel per useful Ton-Mile.
		galls.	qts.	pts.		miles	s.	d.	pence
[1]A1	267	22	—	1	1 pt.	6·38	5	6¼	0·99
[1]A2	272·5	18	1	—	2¾ pts.	7·34	4	6¾	0·80
		cwts.	qrs.	lbs.					
[2]B1	721	18	—	15	1,098 galls.	6·12	3	4¾	0·23
[2]C1	1,014	28	—	—	1,981 ,,	6·02	5	3	0·25
[2]D1	645	17	1	24	1,398 ,,	6·56	3	3½	0·24
[2]D2[3].........	514[3]	18	3	6[3]	1,284[3] ,,	5·70	4	8½	0·33
[2]D3	624	21	2	18	1,447 ,,	4·64	4	0¾	0·31
[2]D4	767	25	1	14	1,516 ,,	6·84	4	9	0·29

[1] Using petrol calculated at 1s. per gallon. [2] Using coke calculated at 15s. per ton.
[3] Three days only.

NOTE.—In these figures it should be noted that the actual useful loads carried exceeded those given in this table by some 10 per cent. to 30 per cent., it being impossible at present to ascertain the precise weights of passengers, observers, and extra fuel supplies.

C. R. D'E.

GENERAL ELECTRICAL ENGINEERING.

1993. *The Deboudé Electric Dynamometer.* **P. Deboudé.** (Ind. Élect. 10. pp. 254–256, June 10, 1901.)—This is a transmission dynamometer in which there is a spiral spring connected at its two ends to a central shaft and at its middle coil to a pulley capable of turning on ball bearings on the shaft. The relative displacement of the pulley and shaft is measured electrically by means of a contact roller, which is mounted on an arm fixed to the shaft and engages with a **V**-groove in a series of contacts on the pulley, equal resistances being connected between adjacent contacts. A constant current is sent through this resistance, *e.g.*, by means of a small magneto-machine having its armature on the dynamometer-shaft, and a dead-beat voltmeter connected to the contact-roller serves to indicate, by the voltage, the displacement of the pulley relatively to the shaft. C. K. F.

1994. *Energy Meter.* **F. Holden.** (Inst. Elect. Engin., Journ. 30. pp. 944–960; Discussion, pp. 960–968, June, 1901.)—A moving vertical spindle carries two shunt coils; these are flat coils, square in section, and are fixed in the same plane, one on each side of the spindle. Each is partially surrounded by a coil carrying the main current, and fixed in a perpendicular plane. The shunt coils can move through a certain angle, from one side of the main current coils to the other, and are held at one side by springs.

A clock closes the shunt circuit periodically, and the shunt coils rotate against the springs to the limits allowed by the surrounding main current coils; a pawl attached to the spindle engages a circular rack, and gives it the same angular velocity as the coils. The rack is mounted on a spindle axial with, but independent of, the spindle carrying the shunt coils, and gearing with the indicating train. A cast-iron disc fixed to the spindle rotates between the poles of a magnet, and by reason of its hysteresis acts as a brake; the spindle carries three weighted arms, to give the moving system a high inertia, and its rotation continues after the shunt coils are stopped till brought to rest by the hysteresis brake. The author shows that the angle through which the spindle turns is proportional to the product of the shunt and main currents. The clock mechanism consists of the seconds wheel and escapement parts of an ordinary clock; it is driven by a weighted lever carrying a pawl which gears with a ratchet wheel on the seconds wheel spindle. When the lever has descended to a certain point, a contact is made which allows current to pass through an electromagnet and raises the lever; this process is repeated about four times per minute. The average power required by the clock is 0·005 watt on a 100-volt circuit.

In the small sizes of meter the loss in the series coils is between five and six watts at full load, and in the shunt coils 0·17 watt. The results of a test show a maximum error of 1½ per cent. in a range from full load to 3 per cent. of full load. The author discusses the errors likely to arise from changes in the brake magnet and from friction.

Discussion.—The author, in reply to several speakers, said that there had been no opportunity to take a time test of the meter; one meter, however, had been at the Board of Trade Laboratory for a year, and two others had been running for six months. The meter had been tested up to 500 per cent.

overload, and was still accurate. He did not think any error could arise from the intermittent registration, in not keeping exact track of the load; at any registration, a positive or negative error was equally likely to occur, and in a three months' run these errors would certainly cancel out. Foucault currents are not induced in the brake disc to any appreciable extent. There is not much difference in the spark on breaking contact with continuous and with alternating currents. G. H. B.

1995. *Integrating Meters.* **H. Armagnat.** (Écl. Électr. 27. pp. 204–212, May 11, and 245–252, May 18, 1901.)—*Hookham Pendulum meter.*—A pendulum allows a clock-train, with indicating dials, to advance during a period of, say, five minutes; a clutch then reverses the direction of motion of the indicating train, so that in the next period of five minutes the train has returned to its original reading, assuming that the pendulum swings at the same rate. The pendulum, however, carries a pressure coil, which swings in a main current coil, so that, when current passes, the swing of the pendulum is quicker; at the same time that the clutch reverses the motion, a commutator reverses the direction of current in the shunt coil, so that in the next period of five minutes, while the train is moving backward, the swing of the pendulum is slower, and the dials at the end of the two periods indicate an amount proportional to the product of the currents in the two coils. An auxiliary clock is employed to reverse the direction of motion and of current. The meter is described fully with diagrams. *Bergmann meter.*—This is a meter of the Aron type with two clocks; instead, however, of registering continuously, a contact is made whenever one clock has advanced over the other an amount corresponding to, say, one-tenth of a unit; the contact closes the circuit of an electromagnet which registers this amount on a train. *Northey meter.*—This is for registering the charge and discharge of accumulators, taking into account the rate of discharge. A drum has a conical surface of form determined by the discharge curve of the battery; this is turned by clockwork and communicates its motion to a pointer through a friction wheel, the position of which on the drum is determined by an ammeter. For charge, the motion of the drum is reversed, and its rate altered so as to allow for the efficiency of the accumulators. The *Johnson and Murday meter* consists of a dynamometer-wattmeter and a clock, with intermittent integration. The *Tourtel meter* registers, by means of a clock, the deflection of an ammeter or wattmeter; a wheel, continuously rotating, during a portion of each turn brings the ammeter pointer back to zero, and during the motion of the latter is geared with the indicating train. In the *Schmidlin meter*, a clock turns a metal disc in the field of a shunt- and of a main-current coil, acting in opposition. At full load, the two fields annul one another, and the clock turns at its normal speed; the smaller the main current, the stronger the resultant field, and the more the clock is retarded. When no main current passes, a finger falls on the disc and prevents any motion. Two meters are described making use of bellows, the size of the escape orifice being determined by the current, and the number of times the bellows is discharged being recorded. G. H. B.

1996. *High-tension Switches and Fuses.* (Journal of Electricity, S.F. 10. pp. 117–139, June, 1901.)—These are a series of papers which were submitted for discussion at the Fifth Annual Convention of the Pacific Coast Electric Transmission Association, San Jose, June 18–19, 1901. **R. S. Masson** makes suggestions on high-tension switching. **F. V. T. Lee**

describes the Martin switch, **W. Currie** describes the latest Stanley types, and **H. C. Wirt** the latest General Electric types. **W. M. McFarland** gives an account of the latest Westinghouse types. In the 2,200-volt 1,000-ampere Westinghouse circuit-breaker the contact surfaces are made by laminated copper brushes against a flat copper block, and the contact pressure helps the releasing spring to throw out the movable arm when it is tripped. The current-carrying contacts are protected by copper shunts, so that when the breaker is opened current is gradually shunted from the current-carrying contacts to the carbons by steps of such low resistance that no arcing occurs.

The Westinghouse fused circuit-breakers are designed for potentials from 6,000 to 40,000 volts. This circuit-breaker is very simple, as it practically consists of two hardwood poles mounted upon a marble base. The poles are hinged so that their extremities are in line at the upper end, and on each is mounted a copper sleeve supporting a carbon contact block with a hole through its centre to hold the fuse wire. The longer pole is provided with spring jaws so that it may be quickly and easily attached to or detached from the terminals on the marble base. A flexible wire runs through the interior of the short pole, and the fuse wire, which is about 6 inches long, is connected across the upper ends of the two rods on poles. When the fuse blows, the short pole falls away from the stationary pole, and thus makes a long break. By means of a long string the fuse itself can be released, thus causing the short pole to drop, and so permitting the device to be used as a switch.

The articles are well illustrated. E. K. S.

1997. *Electric Pumps.* **F. A. Pattison.** (Eng. News, 46. pp. 4–6, July 4, 1901.)—This paper describes the installation of a new form of helical pump with direct drive by an electro-motor for the service of hydraulic elevators, and also for the supply of water under pressure for fire extinguishing, these being applications of very great importance for the very high buildings now becoming common in cities. To a great extent the operation is the same in both cases, being the supplying of a sudden demand for water by means which render this supply practically inexhaustible. As against steam boilers and engines on the premises, electro-motors, fed from the electric supply mains, to work the pumps showed, in the instance cited, a distinct economy.

The installation embraced a system of five hydraulic elevators in a ten-storey building, and there being a 500-volt power line in the vicinity, no steam was used in the building.

Two Quimby double-screw pumps, coupled direct to Eickmeyer electro-motors, were employed, and the governing was arranged so that when either of these units worked up to its full capacity the second one was switched in to share the load. The watt-hours of energy consumed per month were as follows: December 31 to January 31, 2,163,100; January 31 to February 28, 2,563,400; February 28 to March 31, 3,060,100; April 30 to May 31, 3,819,800. The cost of working can be deduced from these.

Whilst steam-pump manufacturers will guarantee an efficiency of 75 per cent. between steam and water, the efficiency between coal and water is very low, as the pumps require a large quantity of steam. In the case of this installation the efficiency between electric mains and water ranged from 47·74 per cent. to 60·05 per cent. Tables of tests are given of a fire-extinguishing plant consisting of a four-pole 75-h.p. motor, running at 675 r.p.m., and wound for 500 volts, direct coupled to a Quimby screw pump with pressure tank, the whole being controlled by a Ford regulator. The efficiency varied from 59·9 to 67 per cent., with a head and lift of 285·5 to 151·5 feet respectively. Figures and curves are given. F. J. R.

1998. *A True Ground Detector.* **T. W. Varley.** (Elect. World and Engineer, 38. pp. 54–56, July 13, 1901.)—It is pointed out that the usual method of detecting a defect in the insulation of live circuits by the use of two lamps is likely to be fallacious, as it really indicates a *balance* of insulation resistance, and the two lamps burn equally, even though the actual resistance varies from nothing to a megohm. A means of definitely indicating a lowering of insulation below a certain standard by the ringing of a bell has been arranged. The author describes the application to an alternating-current station so as to test both the exciting and working sides. A relay is used and the connections so made that when a fault occurs, the potential difference at the terminals is lowered and the armature of the relay falls and establishes the bell circuit. A convenient method of testing the actual insulation by means of a Weston voltmeter is described. It is also shown how signalling may be performed between stations. The system has proved of great service. W. W. H. G.

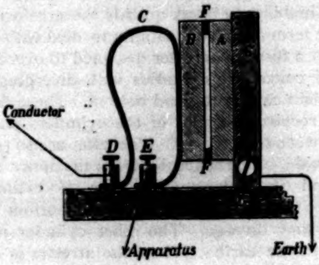
1999. *Lightning Arresters.* **C. C. Chesney.** (Elect. World and Engineer, 37. pp. 942–944, June 1, 1901.)—After enumerating the defects usually met with in alternating-current lightning arresters—too long or too short a spark-gap, bad insulation, inability to break quickly the arc formed by a discharge, exposure of the line terminals, and inability to deal with heavy discharges—the author describes a form of arrester designed to overcome them. It consists of two pairs of concentric cylinders with diverging conical ends held in position by porcelain caps at top and bottom. These caps have concentric circular grooves to receive the ends of the cylinders, and are pierced with ventilating holes between the grooves. The latter are so spaced as to make all spark-gaps $\frac{1}{16}$ inch wide. The space between the inner and outer cylinders is spool-shaped, and the intermediate pair of cylinders have straight generators, except for a short distance at top and bottom on the sides facing one another where they diverge. The inner cylinder is connected to the line and the outer to the earth. When the arrester is in operation, if the dynamo current follows the lightning, a current of air is at once established between the cylinders, and the arc is thereby blown upwards into the wide spaces between the ends of the cylinders, where it is quickly ruptured. At the frequencies usually employed, 5,000 volts or over are required to jump the gaps of this arrester; but at the frequency of a lighting discharge the sparking potential is less than 2,500 volts, so that although the spark-gaps are at least double the widths usually employed, yet the sparking potential at lightning frequencies is less, and the large discharging area of the cylinders enables the arrester to take heavy discharges with ease. Between the arrester and the machine to be protected is placed a coil formed of two coils side by side connected in series, but so that the current circulates in opposite directions, thus making the self-induction of the coil for ordinary frequencies nearly zero. The utility of this arrangement depends on the fact that the impedance of such coils to lightning discharges is practically as great as that of ordinary coils, and hence the discharge finds an easier path to earth through the arrester.

To protect the line from small and low frequency lightning discharges, and from static charges, a line discharger is recommended to be used with the arrester described. This discharger is simply a tube of oxidised metallic particles, with one end connected to the line, and the other, through a minute spark-gap, to the ground, the length of the tube depending on the voltage of the line.

For high-pressure lines, arresters are joined in series. The paper contains diagrams of arresters and of arrester and line discharger connections.

J. H.

2000. *Coherence Phenomena in Carbon Lightning Arresters.* **M. H. Gansauge.** (Journ. Télégraph. 25. pp. 97–99, May, 1901.)—The construction of these lightning arresters is shown in the figure. G is a wooden base-board supporting a metal plate S connected to earth. A number of plates—equal to the number of lines to be protected—of compressed carbon are fixed in a series of parallel grooves in S; and against each of these plates, A, is pressed a second carbon plate, B, by a steel stirrup spring C. The plates A, B, are kept apart by two insulating blocks, F, about 0.08 inch thick, and have their inner edges serrated to facilitate discharge between the plates. The line connections are shown at D and E. In ordinary working no current passes from B to A; but if the line is struck, or inductively acted on by lightning, a discharge takes place along this path to earth rather than along the highly inductive path through the telephone instruments, so that no damage is done to the latter. The carbon plates of the lightning arrester should be very carefully dusted when setting up the instrument, otherwise carbon dust is liable to settle on the insulating blocks, F, and to destroy the insulation. It is not sufficient to test the instrument for insulation in the ordinary way. Experiments have clearly shown that a coating of carbon dust may not destroy the insulation of the blocks until a spark discharge passes, when the dust coheres and forms a short-circuit, as in the well-known case of the coherers used in wireless telegraphy. To make a proper insulation test, therefore, a spark must first be made to pass between the plates A, B; otherwise the instrument may appear all right, but after a time suddenly go wrong without any apparent cause, owing to a short-circuit produced by a discharge between the plates, due to atmospheric causes. Microphones consisting of carbon particles, mixed with carbon dust, are also liable to coherence phenomena, and the noises sometimes heard in telephones, when the circuits are not in use, may be explained in this way.



J. H.

2001. *Electrical Installations in Battleships.* **Grauert.** (Elektrotechn. Zeitschr. 21. pp. 970–977, Nov. 22, and 992–997, Nov. 29, 1900. Paper read before the 8th Jahresversammlung des Verbandes Deutscher Elektrotechn. in

Kiel.)—The author gives a descriptive list of the various ship-lights, signalling-lights, and projectors with which the German ships are fitted. He next compares the different systems of machine and steering telegraphs, rudder indicators, and torpedo signals, giving preference to those constructed by Siemens and Halske. As reserves to these, either speaking-tubes or telephones are installed; the latter, however, are open to some objections. As regards the system of supply, continuous current only is employed, in view of the large amount of power required for the projectors; alternate current is out of the question, on account of the large motor service, and three-phase current has the disadvantage of a more complex network, while the speed of motors can be varied only within small limits. In the latest ships, a voltage of 74 has been adopted as the best adapted to projectors; motors for this pressure have, however, to be specially constructed, and on this account it is probable that the more usual pressure of 110 volts will be finally adopted. Compound machines are now no longer used, on account of the risk in parallel coupling by unskilled men. The switchboards are usually constructed with one negative and two positive bus-bars, so that the motor circuits with variable load may be kept separate from the lighting and the ventilating-motor circuits. A reserve machine and switchboard are usually sufficient only for the lighting, signalling, and ventilation. In the ship *Kaiser Wilhelm II.*, a single lever is arranged so as to change over all these circuits from the principal to the reserve plant. This, though convenient, has the disadvantage that a single shot may damage all the circuits.

The loss of a Spanish ship due to sudden extinction of her lights when entering a harbour, showed the necessity of an accumulator reserve. The battery can be either permanently connected across the mains, or act as an independent source of supply. The former method is not advisable, as either the supply pressure of the battery must be less than the normal voltage, or else the battery must be charged in two series, in which case the reserve is not available during charge. The better system is to instal a battery to supply the signal lamps, which can be charged during the day, while the telegraphs and telephones are supplied by two batteries giving 36 volts each, one being charged while the other is discharged. In the "Fürst Bismark," however, the telephones and telegraphs are supplied from two independent continuous-current transformers, taking current from the main battery of accumulators. Detailed diagrams of the connections in several of the German battleships are given.

The wiring is carried out with lead-covered cable, which is armoured in places where subject to mechanical injury; in the cabins heavily insulated rubber wires are run without casing. The go and return wires are separate, except in the neighbourhood of the compass, where concentric cables are advisable. Soldered joints are avoided, as they are liable to become loose from the vibration of the ship's body, and all branch circuits are connected through distributing bases; these are illustrated and described in detail.

The author finally gives tables showing the power required for the various purposes in five German ships, and also particulars of the dynamos in ten ships. G. H. B.

2002. *Coal Conveyors in Central Stations.* **R. A. Chattock.** (Elect. Rev. 49. pp. 77–78, July 12, 1901. Paper read before the Municipal Electrical Association at Glasgow.)—A station must store at least 100 tons of coal for every 1,000 i.h.p installed. This amount can be conveniently contained in bunkers above the boilers. But it is desirable to store five times this amount, if possible; and for this purpose an auxiliary coal store is necessary, from which the overhead bunkers are supplied by conveyors. The flooring of any coal store should slope at an angle of 45° to points in the centre, from which points a supply of coal is drawn off. The maximum depth stored should be 10 feet; if this is exceeded the coal is liable to become overheated, and to catch fire. The author then describes in outline the various forms of conveying apparatus, including the worm, chain, push-plate, band, trough, bucket, and trolley types, and points out the advantages and disadvantages of each. With regard to elevators, the bucket and grab types are mentioned. Seeing that apparatus of this kind is peculiarly liable to break down, duplicate means should be provided for getting coal into the station. W. H. S.

2003. *Transmission of Compass Readings.* **C. L. Weber.** (Elektrotechn. Zeitschr. 22. pp. 403–405; Discussion, p. 405, May 9, 1901. Paper read before the Elektrotechn. Verein, March 26, 1901.)—The suggested plan of removing the compass to the masthead or other part of the ship remote from magnetic disturbances due to local causes, requires a means for transmitting the compass readings to the deck or bridge. The possibility of being able to replace the compass needle by an earth inductor coil is considered, and various methods for obtaining the best conditions of working are mentioned. Equations for the corresponding currents are given, but no practical system for transmitting and interpreting them has yet been put to the test of experiment. In the discussion, **M. Fuss** described a method in which the receiver is a primitive form of a three-phase motor, consisting of a pivoted astatic needle about which are placed three fixed coils at 120° from each other. The sender is a compass needle carrying insulated contact projections dipping into liquid contained in three annular rings cut in the insulating base-board. The inner two rings contain mercury, and are connected respectively to the terminals of a sending battery. The outer ring contains zinc chloride solution, and contact is made with this solution at three points 120° from each other, by three wires connected respectively to the three coils of the receiver. By means of the contact projections, the compass needle connects the inner mercury ring to the outer electrolyte ring; and by a second pair of contacts, insulated from the first, it connects the other mercury ring also with the outer electrolyte ring. The contact projections are all in the same straight line beneath the moving needle; there is consequently a change of resistance of the circuits corresponding to each angular movement, and a corresponding change of magnetic field at the receiver, causing, it is stated, a corresponding rotation of the astatic needle. R. A.

REFERENCES.

2004. *Controller for Three-phase Induction Motors.* **W. Ephraim.** (Elektrotechn. Zeitschr. 22. pp. 465–466, June 6, 1901.)—The advantages which, in addition to the magnetic blow-out arrangement, are possessed by the controller used for continuous-current motors, are—(1) for each position, a new contact-arm comes into play; (2) the points at which the breaks occur are separated from each other by fireproof partitions. In order to secure the last two advantages for the starting-switches used in connection with three-phase induction motors, the Helios Company has adopted a controller type of switch patented by the author. The paper contains a detailed description, with illustrations, of this type of switch. A. H.

2005. *Covent Garden Theatre.* (Electrician, 47. pp. 85–88, May 10, 1901.)—A general description of the electric stage-mechanism.

GENERATORS, MOTORS, AND TRANSFORMERS.

2006. *Standard Tests for Electrical Machinery.* (Elektrotechn. Zeitschr. 22. pp. 477–480, June 13, 1901.)—This article contains the draft of the report of the Committee appointed by the Verband Deutscher Elektrotechniker for the purpose of standardising the tests to be applied to German electrical machinery. This draft has been drawn up after consultation with manufacturers and experts, and will be laid before the meeting of the Verein at Dresden for consideration. The following points from the proposed regulations may be noted: All temperatures to be taken by means of a thermometer, except in the case of magnet coils; in the latter case, the rise of temperature is to be ascertained by the resistance method, the temperature coefficient for copper being taken as 0·004 per 1° C. In ordinary cases, where the air temperature does not exceed 35° C., the rise of temperature in insulated windings, commutators, and slip-rings, is not to exceed the following amounts, viz., for cotton insulation, 50° C.; for paper insulation, 60° C.; for mica and asbestos, 80° C. For stationary windings these figures may be exceeded by 10° C. For tramway motors, after one hour's run at full load, the above figures are to be taken as 70°, 80°, and 100° respectively. All machines to have a plate stating voltage, current, periodicity, power factor, &c. The plate is also to state whether they are intended for intermittent or continuous use; for these two classes of machinery different regulations are prescribed. All generators, motors, and rotary converters are to stand an overload of 25 per cent. for half an hour without exceeding the above-stated temperatures; similarly motors, rotary converters, and transformers are to stand an overload of 40 per cent. for three minutes. Generators must be able to keep the voltage constant up to 15 per cent. overload, when running at constant speed, the power factor in the case of alternators being taken as not less than that stated on the plate. The insulation of all machines must be able to withstand the following tests for half an hour, viz., twice the working pressure for machines under 5,000 volts; an increase of 5,000 volts on the working pressure for machines between 5,000 and 10,000 volts; above this limit the testing pressure to be one and a half times the working pressure. In case the insulation of direct-current machines is tested with alternate current, the above pressures to be multiplied by 0·7. These tests to be carried out when the machine is hot. The efficiency of the machine is to be determined by one or other of the eight methods laid down in the regulations, it being assumed for the purposes of the test that in the case of an alternate-current machine the power factor is unity. Conditions are also laid down for the determination of the drop in voltage between no load and full load in the various types of machinery. W. H. S.

2007. *High-frequency Alternator.* **H. F. Chadwick.** (West. Electn. 28. pp. 440–441, June 29, 1901.)—A discussion of the "skin effect" produced in conductors subjected to a potential difference alternating at high frequency, followed by a short description of the high-frequency alternator designed by W. L. Hooper and used for experimental purposes at Tufts College. The alternator is driven by a direct-current motor mounted on the same base and coupled direct; the speed is 2,500, which, with 48 armature coils (the number on the machine), gives a periodicity of 1,000 per second. The alternator is of the Mordey type; all the armature coils are provided with terminals, so that they can be coupled in series or in various combinations of series-parallel. The output of the machine, with the coils in series, is from 7 to 10 amperes at 100 volts. The Mordey field is 16 inches in diameter and consists of two cast-iron crown wheels with teeth milled out of the solid. The axial magnetising coil is of the usual Mordey type, and the collecting rings are mounted on one face of the field, the brushes being set horizontally. The armatures of motor and generator are each mounted on ball bearings; there are three pedestals, the intermediate one being common to both, and the two shafts are connected by a clutch in the body of the pedestal. Friction is reduced to a minimum by the ball bearings; the machine takes ten minutes to come to rest from full speed with all circuits open. The e.m.f. curve is very nearly a sine wave. The paper is illustrated by a photo block and a detail drawing (plan and elevation). B. P. S.

2008. *Polyphase Sub-station Plant.* **H. S. Meyer.** (Elect. Rev. 49. pp. 5–7, July 5, 1901.)—The author continues the discussion of the questions raised by Hobart and Eborall [see Abstracts Nos. 1802, 1822, and 1823 (1901)]. The discussion hinges mainly on the following points: (1) whether or not damping coils are essential to rotary converters, and the amount of the losses occasioned by their use; (2) the efficiency of the rotary converter, including auxiliary apparatus in the shape of transformers, damping coils, &c., as compared with the synchronous motor-generator; (3) the pressure tests to be applied to armature insulation; and (4) the amount and calculation of the necessary fly-wheel effect. With regard to (4), the following is the method employed by the General Electric Company, of America, for determining the variation of the angular velocity of the flywheel. A bicycle wheel is directly connected to a ½-kw. bipolar generator, and mounted so that the tyre presses against the rim of the engine flywheel. The field is excited by a storage battery, and the armature is connected in opposition to another battery. A voltmeter is connected between the two. The voltages of this battery and of the dynamo are adjusted so as to be nearly equal, and any variation in the angular velocity will therefore be reproduced on the voltmeter. The method, being differential in its action, is very sensitive.

The article contains some calculations referring to matters connected with the flywheel effect, and the allowable variation in angular velocity. **Eborall** published a reply in the Elect. Rev. July 12, 1901, pp. 51–52; and **Meyer** published a counter-reply in the Elect. Rev. July 19, 1901, pp. 95–96.

W. H. S.

2009. *Theory of Synchronous Motors and of Alternators in Parallel.* **A. Russell.** (Elect. Rev. 48. pp. 919–921, May 31, pp. 995–996, June 7, and 49. pp. 88–89, July 19, 1901.)—This is a theoretical discussion demonstrating the following results:—

(1) There is only one position of lag or lead of a synchronous motor on a given load where the equilibrium is stable.

(2) It is necessary to adjust the excitation of both the motor and the generator when we wish to get the maximum efficiency.

(3) It is misleading to refer to a synchronous motor as having a certain power factor at a particular load. The power factor of a motor circuit is a variable that depends not only on the shape of the wave of the generator, but also on what is happening outside the motor circuit.

(4) The greater the excitation of two alternators working in parallel, the nearer the angle of lag between the synchronising e.m.f. and the synchronising current is to 45°, and the less the resistance of the circuit of the armatures the better they will work in parallel.

(5) Alternators will in some cases cease to work in parallel on heavy inductive loads. This could be remedied by connecting condensers or over-excited synchronous motors either directly or through the medium of a transformer to the bus-bars. W. G. R.

2010. *Theory of Synchronous Motors.* **A. Blondel.** (Écl. Électr. 27. pp. 429–442, June 22, 1901.)—The elementary theory of a generator and a synchronous motor is first discussed, the permeability of the inductor circuit being considered constant. If E_1 and E_2 be the generator and motor e.m.f.'s, $\pi-\theta$ their phase difference, I the current, Z the impedance of the whole circuit, γ the angle of lag of I behind the resultant of E_1 and E_2, and P_1, P_2 the power given out and absorbed by the generator and motor respectively, then—

$$(ZI)^2 = E_1^2 + E_2^2 - 2E_1E_2\cos\theta$$

$$P_1 = \frac{E_1}{Z}\left\{E_1\cos\gamma - E_2\cos(\theta+\gamma)\right\},$$

$$P_2 = \frac{E_2}{Z}\left\{E_1\cos(\gamma-\theta) - E_2\cos\gamma\right\}.$$

The ordinary diagram of the working of the two machines in series is simplified by choosing different polar axes and different scales for the e.m.f.'s and currents. The line on the diagram that represents the resultant e.m.f. (ZI) also represents the current (I). Lines OA_2 and OA_1 representing E_2 and E_1 are drawn inclined to one another at an angle θ so that A_1A_2 represents ZI. When we are considering the case of E_2 fixed, a line YA_2Y' is drawn making an angle $\pi-\gamma$ with OA_2. Then we can regard A_1A_2 as a vector representing the current, the angle A_1A_2Y representing the phase difference (ϕ) between I and E_2. We thus get a bipolar diagram, the vector E_1 rotating about O whilst the vector I_1 rotates about A_2. This simplifies the theory. The author shows, for example, how the V curves can be found from a purely graphical construction. A numerical example of two Mordey alternators (2,000 v., 18·5 a.) operating through a line 10 kilometres long is completely worked out. The constants of the armatures, determined from the characteristic curves given by Mordey, are 3 ohms resistance and 43 ohms reactance.

The latter half of the paper treats of the variation of the reactance of a synchronous motor under various conditions of working. The variable inductance of the armature can be found from two reactions which can easily be calculated in practice. The first reaction directly opposes the magnetising turns of the inductor poles and may be written $k\dfrac{nI\sin\phi}{\sqrt{2}}$ and the second reaction $k'\dfrac{nI\cos\phi}{\sqrt{2}}$ acts transversely on the poles. These magnetising forces act on different magnetic circuits. In the formulæ k and k' are constants, n is the number of armature windings in the field of an inductor pole, and ϕ is the phase difference between I and E_2. The saturation of the inductor poles is taken into account, as knowing the ampere turns we can get the resultant flux in them from the excitation curve of the machine found experimentally on open circuit. The transverse flux can in general be represented by $LI\cos\phi$ where L is a constant. A graphical method is given of finding the wattless current (I sin ϕ) as a function of the excitation, and hence the true V curves can be found. The author states that the principle of two reactions also directly applies to the study of rotary converters. A. R.

2011. *Polyphase Induction Motors.* **R. D. Mershon.** (Elect. World and Engineer, 37, pp. 966–967, June 8, 1901.)—In this paper the author compares the polyphase-induction motor with the direct-current motor with regard to starting torque, speed control, disturbance at starting to the voltage of supply, and power factor. The induction motor may have a higher starting torque than a direct-current motor under any conditions. The direct-current shunt motor and the induction motor with slip-rings and rheostat in the secondary circuit are identical as to speed control, and the same applies to a motor without slip-rings, controlled by varying the impressed voltage. The disturbance to the circuit is slightly greater with the induction motor, owing to the power factor being less than unity. With an induction motor without slip-rings, started under load or run below speed, the disturbance will be greater since the power factor becomes less. Power factor does not affect the efficiency of the polyphase induction motor; it only affects the supply circuit, and is modified by the power factor of other apparatus on the same circuit. In conclusion the author discusses the relative efficiency and cost of direct current and polyphase induction systems for power service. The synchronous motor is ignored as not being sufficiently simple or reliable under varying conditions. B. P. S.

2012. *Efficiency and Running Cost of Shunt Motors.* **B. Frankenfeld.** (Elect. World and Engineer, 38. pp. 17–19, July 6, 1901. Paper read before the North-western Electrical Association.)—The method of determining the efficiency by measuring the losses is recommended; an example is fully worked out for a 5-h.p. motor. The effect of varying the incidence of the losses in different motors is then shown by means of curves, and it is pointed out that shunt motors which have their maximum efficiency at a small percentage of their full load have very poor speed regulation; this may be remedied by differential compound winding. The effect of efficiency upon running cost under steady and variable loads is dealt with, and it is recommended that for general purposes the maximum efficiency should occur at three-quarters of the full load. A summary of conclusions is given, in which it is stated that the maximum efficiency occurs when the ohmic loss in the armature equals the sum of the fixed losses; an early maximum impairs the regulation, but a late maximum gives greater overload capacity; the maximum efficiency should not in general occur at the average load. A. H. A.

2013. *Heating of Magnet Coils.* **S. S. Neu, A. J. Levine,** and **O. A. Havill.** (Elect. World and Engineer, 38. pp. 56–58, July 13, 1901.)—An investigation with the objects of determining the distribution of heat in the coils of field magnets under various conditions, the relation between rise of temperature and watts per square inch of radiating surface, the time required for coils to heat and cool, and the relation between the rise of temperature as measured by thermometer and as measured by increase of resistance. The experiments have been carried out in a complete and interesting manner. The coils used were from two shunt 115 volt, 1 and 5-h.p. motors. The coils were specially wound in 16 sections of equal cross-sections so as to admit of finding the temperature by the resistance method in any of the 16 compartments. The coils were tested (*a*) supported entirely in air, (*b*) resting on a table, (*c*) in place on the machines, and (*d*) with the machines running at full load. The coils were heated for six hours at their rated voltage under each of these conditions. Isothermal curves were plotted. The ratio between the rise of temperature of the hottest point of the winding and the mean rise of temperature was in the four cases—(*a*) 1·185, (*b*) 1·17, (*c*) 1·21, (*d*) 1·12. A coil whose surface is all exposed to the air radiates 0·00292 watt from each square inch of surface for each degree difference in temperature between the coil and the air, and finally the following simple formulæ are deduced :—

For electromagnets $W = TS/100$;
For field magnets $W = TS/110$,

where T = allowable rise of temperature in degrees C.,
W = watts which will produce this rise,
S = outside cylindrical surface of coils in square inches.

Formulæ are also obtained for the rate of heating and of cooling, and it is shown that the time required for a coil to attain a constant temperature is proportional to its cylindrical surface divided by its volume. One of the useful results is a comparison between the thermometer and resistance methods. According to G. S. Dunn, it is stated that the temperature as measured by a thermometer can be varied by 5° by changing the method of measurement. To obtain uniform results he limits the amount of cotton-waste usually applied over the thermometer's bulb to prevent radiation. He advises the use of a fibre tube 1¼ inches diameter and 4 inches long with a slot in one side. This is pressed against the surface to be measured, the thermometer inserted in the slot, the box then packed with cotton, and the whole tied to the surface with rubber tape. Dunn also remarks that the difference between resistance and thermometer measurements is greater than is implied by the rules of the American Institute of Electrical Engineers. The authors find (using Dunn's device) that there is no simple relation between the thermometer rise and the rise by resistance. In practical cases the ratio is not above 0·6. W. W. H. G.

2014. *Testing Large Transformers.* **J. S. Peck.** (Elect. World and Engineer, 37. pp. 1083–1086, June 22, 1901.)—The transformers in question (seven in number, each of 2,250 kw. capacity), were installed near Buffalo, N.Y., by the Cataract Power and Conduit Company, for the purpose of reducing the pressure of the Niagara Falls three-phase transmission circuit from 22,000 to 11,000 volts. Each transformer is enclosed in a case of boiler plate, with oil-insulation, the oil being cooled by a circulation of cold water through spirals of brass tubing. A thermometer shows the temperature of the oil, and automatically sounds an alarm gong when this reaches a certain value.

The following figures are given as the result of actual tests :—Efficiencies : Full load, 98·65 per cent. ; three-quarter load, 98·58 per cent. ; half load, 98·33 per cent. ; quarter load, 97·2 per cent. ; pressure drop on a non-inductive load, 0·76 per cent. ; on a load with power factor of 80 per cent., 1·8 per cent. Actual temperature rise as measured by increase in resistance, 28·7 per cent. All transformers stood the following high-pressure tests : 45,000 volts for one minute between high-tension and low-tension winding, and between high-tension winding and core ; 22,500 volts for one minute between low tension winding and core ; 49,400 volts on the high tension winding (induced by 2¼ times the normal voltage applied to the low-tension winding) for thirty minutes. Resistance was measured by passing a current of about 6 amperes through the coils from storage cells and taking the fall of potential by means of a voltmeter, a high resistance being inserted in series with the windings. It was found necessary to short-circuit one of the other windings when making the test, in order to obviate the danger to the instruments which would result from the high e.m.f. which would be induced in the circuit due to even a slight change in the current. The effect of the short-circuited windings is to increase the time necessary for the magnetic field to reach its full strength after the current is switched on; with the low-tension coils all in series the time required is about thirty minutes; with the high-tension coils all in series, about three minutes. A true reading of the pressure drop is only obtained after the field has become stationary, as the changing field induces an e.m.f. in the coil which adds itself to the voltmeter reading; curves are given showing the apparent decrease of resistance of the coils with time. Total iron losses were measured in the usual way by a wattmeter. To separate the eddy current from the hysteresis loss the latter was measured by a method due to C. F. Scott. A direct current is sent through the low-tension winding and gradually increased or decreased. The changing field induces an e.m.f. in the transformer winding which is measured by a voltmeter across the high-tension winding. The voltmeter needle was found to remain steady at a reading of 0·1 volt when the field changed at the rate of about 6 c.g.s. lines per sq. cm. per second; hence, the resistance being gradually cut out so as to keep the voltmeter steady at this value, the time from the start is a measure of the induction in the iron. When the maximum desired induction is reached the voltmeter is reversed and the current gradually decreased to zero, and so on till the cycle is complete. Readings being taken of time and current (the voltmeter needle being held steady the whole time) a curve is obtained from which the hysteresis loss can be readily estimated. The eddy current loss is then obtained by deducting the hysteresis from the total iron loss. Efficiency and hysteresis curves accompany the paper, and also photo blocks showing the transformers in different stages of assembling. B. P. S.

2015. *Reactance Drop and Reactance Factor of Transformers.* **A. E. Kennelly.** (Elect. World and Engineer, 38. pp. 92–94, July 20, 1901.)—For any definite load a transformer is equivalent, so far as the external primary circuit is concerned, to a certain choking coil inserted in the primary circuit. The percentage of the drop of pressure in the equivalent choking coil is equal to the percentage of the drop of pressure actually occurring in the secondary of the transformer. If e_r and e_x be the resistance and reactance drops in the equivalent choking coil, then—

$$e_x = \left\{ E_1^2 - (E_2 \cos\theta + e_r)^2 \right\}^{\frac{1}{2}} - E_2 \sin\theta,$$

where $\cos\theta$ is the power factor of the load on the secondary circuit, E_1 the primary volts, and E_2 the volts at the secondary terminals multiplied by $\frac{n_1}{n_2}$, where n_1 and n_2 are the primary and secondary turns respectively. Now e_r can be calculated from the resistance of the primary and secondary windings, and hence e_x can be found from the formula. The author defines the ratio of e_x and e_r as the reactance factor of the transformer, and says that it varies in practice between 2 and 20 depending on the size, pressure, and design of the transformer. The lower the reactance factor the better the regulation of the transformer. With a good transformer of low reactance factor on a non-inductive load, e_r is approximately equal to $E_1 - E_2$, and hence can be found without calculation. The following approximate formula for the reactance factor (f) is given :—

$$f = \frac{N - n\cos\theta}{n\sin\theta},$$

where N is the percentage secondary drop of a transformer on inductive load of power factor $\cos\theta$, and n is the percentage secondary drop of the same transformer on non-inductive load. Suppose, for example, that a transformer has a secondary drop of 0·75 per cent. at full non-inductive load, and a secondary drop of 1·8 per cent. at full load current on a power factor of 0·8, then $\cos\theta = 0{\cdot}8$, $\sin\theta = 0{\cdot}6$, $n = 0{\cdot}75$, and $N = 1{\cdot}8$; hence $f = 2{\cdot}67$. The reactance drop in this transformer is thus $2\frac{2}{3}$ times the resistance drop. A table is given, calculated on the sinoidal assumption, of the reactance factors of transformers on various inductive loads when the ratio of the inductive load drop to the resistance drop is known. A. R.

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2016. *Alternator Diagrams.* **L. Barbillion.** (Écl. Électr. 27. pp. 408–413, June 15, 1901.)—Simple diagrams illustrating the working of an alternator connected on to a network of mains are given for distribution at constant e.m.f., at constant current and at constant p.d. Proofs of these diagrams assuming the ordinary sine-curve theory are given, and the conclusions to be deduced from them illustrate clearly some of the main phenomena observed in practice. A. R.

2017. *Aluminium for Electrolytic Rectifiers.* **C. Pollak.** (Comptes Rendus, 132. pp. 1405–1408, June 10, 1901.)—Note on the forming of aluminium plates for this purpose. A. D.

2018. *Standard Tests for Electrical Machinery.* **G. Dettmar.** (Elektrotechn. Zeitschr. 22. pp. 499–506, June 20, 1901.)—The author here publishes some notes on the Report of the Committee appointed by the Verband Deutscher Elektrotechniker for the consideration of this subject [see Abstract No. 2006 (1901)]. He states the reasons which led the Committee to adopt the various regulations, and adds suggestions as to the best means of carrying out the tests, and the precautions to be adopted to secure satisfactory results. W. H. S.

2019. *Starting Rolary Converters.* **A. B. Weeks.** (Amer. Electn. 13. pp. 358–360, July, 1901.)—Some notes on the starting of rotary converters from the practical point of view. The information, which is given in some detail, cannot well be condensed. W. H. S.

ELECTRICAL DISTRIBUTION, TRACTION AND LIGHTING.

ELECTRICAL DISTRIBUTION.

2020. *Resonance in Continuous-current Circuits.* **H. Armagnat.** (Écl. Électr. 27. pp. 465–468, June 29, 1901.)—The voltage curve of a continuous current dynamo is not an exact straight line. The deviation from the mean in a 60-ampere 120-volt dynamo with a Gramme ring experimented on was 1 or 2 volts. On putting a four-pole motor with a slotted armature in circuit, the maximum amplitude of the voltage variation became 14 volts. The number of segments on the commutator of the motor was 24, and its speed 1,200 r.p.m. Hence the frequency of the superposed alternating voltage was 480. The current taken by the motor was only about 4 amperes. Putting an induction coil (L) and a condenser (K) in series across the circuit and adjusting to resonance, then if E be the effective alternating voltage between the mains and V the voltage across the choking coil,

$$V = \frac{2\pi f L}{R} E.$$

In the experiment $L = 1$ henry, $R = 105$ ohms, $K = 0{\cdot}11$ microfarad, $f = 482$, $V = 140$ volts. Therefore E is 4·85 volts, and if the wave be sinoidal the maximum value of E is 7 volts on either side of the mean voltage. On varying K to 0·10 or 0·12 microfarad, V dropped to under 20 volts. It is suggested that this arrangement can be used for indicating harmonics or indicating speeds. Apparently inexplicable breakdowns of cables in continuous-current circuits may be due to resonance. When a Wehnelt or Caldwell interrupter is put on commercial circuits a difference of 4 or 5 volts is sometimes noted between the readings of thermal and magnetic voltmeters which ordinarily read the same. In the circuit experimented on above, a Wehnelt interrupter made the maximum voltage 240 volts, *i.e.*, double the mean voltage. Mechanical resonance also can be caused by the undulations in commercial continuous currents. A. R.

2021. *Dielectric Losses in Condensers and Cables.* **C. V. Drysdale.** (Electrician, 46. pp. 890-892, April 5, 1901.)—The author proposes the use of condensers in transformer substations to provide a current in quadrature, to be supplied by an auxiliary line for starting single-phase motors. A 20-microfarad condenser on a 2,000-volt 50 ∿ circuit takes 18·5 amperes, and this, if transformed to 100 volts, would give 250 amperes in quadrature with the lighting mains, and would be sufficient for starting a large number of motors. The dielectric loss in the condenser would be a serious objection to this system, and the author gives the result of measurements of the power factor of various cables and condensers. He also has compiled a table summarising the power factors measured by Ayrton, Mather, Hóor, and Addenbrooke.

G. H. B.

2022. *Power lost in the Dielectric of Cables.* **W. M. Mordey.** (Inst. Elect. Engin., Journ. 30. pp. 364–387; Discussion, pp. 396–473, April, 1901.)—With sine-curve alternators the capacity current in a cable = *Volts* × *periods per* *second* × *microfarads* × $2\pi \times 10^{-6}$. On a particular rubber insulated 37/15 cable for 7,000 volts this measure was found to be independent of the voltage, and the capacity therefore did not vary with the pressure. The C^2R loss due to the capacity current is small, as is also the leakage loss, but the loss of energy due to rapidly reversing the strain on the dielectric in the above cable was large, namely, 0·124 of the "volt-amps" or "apparent watts." The author says that this dielectric loss may be diminished by increasing the thickness of insulation, and that it resembles magnetic hysteresis, from which it differs by showing no saturation effect. Possibly at very high pressures the proportionality may cease and the curve begin to bend down towards the axis of volts. This loss continues always, and often is more important than the C^2R loss. Thus on 40 miles of cable having 0·5 mfd. per mile and working at 20,000 volts (50 ∿), 800,000 units would be wasted per annum. A choking coil should be placed in parallel with the capacity and if it takes a self-induction current equal to the capacity current, the two will neutralise. The dielectric loss in small cables is disproportionately large because the capacities do not much lessen with decrease of size. The dielectric loss is said to be proportional to the square of the pressure. The author has noticed that when extra high-tension mains are switched on, the engine has been checked much more than would be consistent with the production of merely wattless current. Particulars are given of a choking coil with closed magnetic circuit used to reduce the wattless current on 5½ miles of 37/15 7,000-volt mains. The reduction due to the ordinary transformers is very small, and the author prefers to keep to transformers with a low power factor and to provide separately for any compensation that may be necessary. An over-excited synchronous motor acts as a capacity and takes a leading current; when under excited it takes a lagging current.

Discussion.—**W. E. Ayrton** pointed out that ammeter readings had already been used to measure capacities and that the method was not novel. He claimed to improve on Mr. Mordey's choking coil by giving to the inductive shunt a value of—

$$\frac{1 + \sqrt{1 + 4F^2p^2o^2}}{2Fp^2} \text{ henries}$$

where F is the capacity of the cable in farads, p is 2π times the frequency, and o the resistance in ohms of the inductive resistance placed as a shunt to the condenser. By making a shunt from this formula, the alternator current will be reduced to 0·075 ampere. In his experiments Mordey ought to have used no iron in his choking coil. The watt-hour meter used to determine the loss did not read correctly with the low power factor for reasons stated in a paper of March 24, 1893, in the *Electrical Engineer*. The losses he had found in condensers gave a power factor of 0·01 instead of Mordey's value of 0·124. **C. P. Sparks** mentioned that the capacity loss can be diminished by energising a minimum number of cables. A paper cable would have diminished any inconvenience from capacity by one-third. Five and a-half miles of concentric rubber cable having 0·86 mf. capacity from inner to outer and the outer earthed, with insulation of 6,000 megohms per mile, at a periodicity of 100 and a pressure of 2,000 volts, showed a loss of 1,509 watts in the cable alone, 530 watts in Mordey's choker alone, and 495 watts in choker alone with the keeper on. The meter revolved in one direction when connected to the cable and in the reverse when connected to the choker. To check these (Mordey's) measurements, a cable was tested by measuring the difference of power required to drive an alternate-current generator driven by a direct-current motor. It was then noticed that the wave form of this generator caused the capacity current to be 2·1 times higher than it would have been with a sine wave, and eventually the power factor obtained with a sine wave was 0·04. Mather had re-tested the particular cable tested by Mordey. Ayrton's choking coil weighed 80 lbs., and the current in the alternator was 2·7 amperes; the power factor came out at 0·034. **J. A. Fleming** recalled that D'Alton had measured the power wasted on the Deptford scheme by taking careful indicator diagrams of a single engine both before and after it was connected to the capacities of the cable; the current was about 45 amperes at 10,000 volts; the power factor was nothing like 12 per cent. but may have been 2 per cent. **W. E. Sumpner** pointed out that the magnitude of the cable loss ought not to be considered in itself, but as compared to the load the cable is intended to transmit. The loss in the choker was likely to be about 4 to 6 per cent., and as against 2 per cent. which the speaker thought was the correct figure for the dielectric loss, therefore the choker loss was more important. A wattmeter may read accurately on a circuit of low power factor, say 0·02 if the circuit carries a lagging current, yet the same instrument may read wrong and even negatively if the current is a leading one. Particulars of the test on Mordey's wattmeter were therefore required, and he believed Mordey must have had a transformer in connection with his wattmeter and the difference in phase of 4 or 5 degrees between the primary and secondary circuits might produce the extraordinary results when the transformer is used for tests depending on phase. **J. Swinburne** expressed the opinion that the loss in cable dielectrics being continuous is important, even if small in comparison with the carrying capacity of the cables; it probably varies with temperature. The dielectric loss is probably a C^2R loss and has been rashly called *hysteresis*, for condensers in series with resistances show apparent "dielectric hysteresis." Insulators that heat most are those whose specific capacities are abnormally high in relation to their refractive indices, and this would tend to show that there is a molecular conduction, or paths of low resistance, the paths having lengths of the order of the dimensions of molecules. **T. Mather** objected to the general conclusion of high power loss, and considered that recording wattmeters are inaccurate at low power factors. He recommends as a convenient method of measuring the losses in a dielectric the use of an ironless choker of suitable inductance for bringing the current in phase with the volts. The coil losses are very closely the C^2R losses and the difference between the C^2R and wattmeter readings gives the loss in the cable. (See Ayrton, Electrician, Jan. 18, 1901; Mather, Electrician, Jan. 25, 1901; Rosa and Smith, Phys. Rev. Vol. 8. pp. 1–20, 1899.) The losses found on long cables were as follows:—

	P.D. in volts.	Frequency.	Power factor.	Maker.
Oiled paper, low-pressure cables tested at 2,000 volts	2,017	100	0·024	B. I. W. Co.
Jute	2,030	71·5	0·027	Callender Co.
Indiarubber	2,000	105	0·028	Silvertown.
Indiarubber (same as tested by Mordey	2,230	100	0·029	Do.
Indiarubber (Mordey's test)	2,040	100	0·124	Do.

The effect of wave form on the number of volt-amperes taken by a cable is important; they vary by 50 per cent. with the load on the alternator, and by 58 per cent. according to the alternator used. **M. O'Gorman** stated that the loss of energy in a condenser or cable dielectric depends approximately on the square of the potential difference applied between the sides of the dielectric in question. Hence the energy lost depends on the distribution of potential within the thickness of the insulation, and this in turn depends on the grouping of the material in the various layers which constitute the insulation. In rubber cables the specific capacity of the layers is extremely irregular in oil and paper, and oil and jute fairly so. He gave a diagram of the potential distributed across a cable insulation to show that the energy loss may be six times greater with heterogeneous than with homogeneous insulation, unless the specific capacity of the insulation in the heterogeneous case is scientifically graded. Explanation is given of the greater loss when the curve of alternations is peaky. **W. E. Gray** would undertake to make rubber cables of any capacity, but this is different from guaranteeing that the capacity will not vary very considerably when the cable is ageing. **R. Threlfall** objected to the term dielectric hysteresis; even the ohmic resistance of a substance varies under the electric intensity of the test. Arnó and Steinmetz could not have deduced "hysteresis" from an experiment from which conductance loss was not eliminated. There is only a slight relation between the absorption of a condenser and the heating losses when it is supplied with an alternating current having a frequency of 30 or 40 per second: nine-tenths of the so-called absorption losses are due to spreading over the surface of the dielectric beyond the armatures, and the air-discharges between the armature and the dielectric surfaces. By eliminating air and moisture the losses may be reduced enormously. With paraffin oil and vaseline on pure cellulose paper applied under a vacuum it was reduced to nearly 0·1 per cent. He objected to the proposal to measure the work done by the square of the electric force. It was to be measured by some power between 1·5 and 1·9, and it only reaches the square with a heterogeneous dielectric such as he had made with paraffin and graphite. **T. H. Minshall** tabulated: (1) the effect of wave form on the quantity of capacity current, (2) the power factors of cables with different wave forms, and (3) the effect on the capacity current of a small load at the end of a cable. He had obtained a power factor of 0·1 on a cable whose insulation resistance was low, and this confirmed Mordey's test. **H. M. Sayers** pointed out the advantage of using iron core chokers for portable cable testing sets. He anticipated trouble from resonance as frequency is reduced. He endorsed O'Gorman's remark that the slope of potential in each layer is inversely proportional to the specific capacity, and suggested that the loss in multiphase cables may have been due to the fibrous packing and layers of air between the individual cores. If the dielectric power factor increases faster than the pressure, this may be due to heterogeneity. The cost of running a generating set in practice and producing only displacement current is about 20 per cent. of the cost of running it loaded. **W. B. Esson** considered that capacity in cables was a blessing in neutralising to some extent the lagging current always present in a general scheme of distribution. In the Power Bill schemes, the long lines will give a high capacity, but the power circuits will give rise to a correspondingly large lag. He did not think that sensibly larger engines would be required to supply the wattless current. **E. Wilson** suggested a method of measuring the dielectric power loss by means of two wattmeters with their moving systems coupled together. **A. Russell** pointed out that a very small variation from the sine wave-form of current considerably modifies the balancing action of condenser and choking coil. **G. H. Nisbett** corroborated Ayrton and Mather's tests on British Insulated Wire cables, and, assuming that the dielectric loss given by Mordey should be divided by 15, works out the loss of power which will occur in the system projected by the Midland Power Company; taking the load-factor at 12½ per cent., the loss would be 0·4 per cent. **E. G. Cruise** gave details of two three-phase, three-core, high-tension cables, and showed that the percentage loss of power in the dielectric was far less with such cables than with single-phase concentric cables. **A. Whalley** gave three sets of e.m.f. and current curves of one alternator when working on a transformer load, on a a capacity load, and on a load of capacity in resonance with a choking coil. These curves show that, before using the coil, it is important to know the peculiarities of the alternator on a capacity load. **L. Andrews** agreed with Mordey in thinking that the generation of the charging current may be a serious expense. At Hastings, between midnight and 4 p.m. during last year, the output in volt-ampere units was as follows: useful work, 94,600 units; exciting transformers, 35,000 units; capacity current, 58,400 units. He reckoned that the cost of generating the capacity units was between £300 and £400. **W. E. Ayrton** gave particulars of the ironless choking coil made by Mather to replace Mordey's; its weight was about one-third of the latter's, and the power wasted in it three-fifths, while the current in the mains was reduced to a lower value. He then examines the conditions which give a negative deflection on a wattmeter when applied to measure a capacity current. **Mordey,** in reply, mentioned a communication from Kapp, who has found high-tension, three-phase cables appreciably warm on light loads, indicating a considerable dielectric loss. This is confirmed by several other cases of dielectric loss, verified, not by wattmeters, but by engineering methods admitting of no question; if Ayrton and Mather's measurements be correct, they merely show, as was pointed out by various speakers, that dielectric loss is a very variable quantity in different cables. Taking Ayrton and Mather's lowest figure for the true power factor, and applying this to several cases in actual practice, he shows that the loss is a large percentage of a supply company's profits. M. O'G.

2023. *Self-induction and Capacity in a Lighting Network with Concentric Cables.* **G. H. Julius.** (Assoc. Ing. Él. Liège, Bull. 11. pp. 537–557, 1901.)—The author made measurements on the network of the Société Anonyme Belge Éclairage Électrique de Saint-Pétersbourg. Eight concentric cables, with rubber insulation, and a total length of 21·4 kilometres, were available for measurement, and from these the author found the dielectric constant of the rubber to be 3·3. From this figure the total capacity of all the high-tension feeders, of a total length of 243 kilometres, was calculated as 87·8 microfarads. The charging current of these cables at 2,000 volts and 42·5 ∿ is 46·8 amperes. Experiments made on the eight feeders mentioned showed that the charging current increased rather more rapidly than the pressure.

The transformers connected to the network are 950 in number, of a total capacity of 8,423 kw., the units varying in size from 0·75 kw. to 40 kw. The author made a large number of measurements on these transformers, which are given in a table at the end of the paper. The total open-circuit loss is 237·5 kw., and the total wattless current is 241·5 amperes. Combining these figures with those obtained for the capacity of the cables, the current at no load is calculated to be 228 amperes, with a power factor of 0·52, while without the cables the current would be 270 amperes and the power factor 0·44. To bring the capacity and self-induction into complete balance, the capacity of the cables would have to be quintupled. At full load, the effect of the self-induction is negligible, the power factor being 0·991.

G. H. B.

2024. *An Artificial Forty-mile Transmission Line.* **W. S. Aldrich** and **G. W. Redfield.** (Amer. Inst. Elect. Engin., Trans. 18. pp. 451–473, June and July, 1901.)—The artificial duplication and test of a forty-mile transmission line was carried out in the Electrical Engineering Laboratory of the University of Illinois. A fairly complete investigation is given of the effect of varying the magnitude and power factor of the receiver loads on the regulation and efficiency of the system. It is stated that the ohmic loss in the line according to the best modern practice is from 5 to 10 per cent. at full load. Step-up and step-down three-phase transformers are used and it is assumed that the efficiency is to be at least 80 per cent. at full non-inductive load. The external characteristics of the Westinghouse three-phaser for lagging and leading currents are found and diagrams illustrating the relation between the charging current and the resonant rise on the line, &c., are given. These diagrams verify Perrine's formula [see Abstract No. 2325 (1900)]. A diagram is given illustrating how the ratio of transformation of a transformer varies with the power factor of the load. It is found that the secondary volts rise as the phase difference between the secondary e.m.f. and current diminishes, and continue to rise when this becomes negative. The experiments illustrate the paramount importance of keeping the capacity currents of the mains as small as possible. Interesting oscillograph pictures of the wave forms at both ends of the line are given. They show that the bad regulation of the earlier systems was due to wave-form peculiarities owing to the various types of generators, &c., used. It is proved that when synchronous motors or converters are used giving wave forms unlike those of the impressed e.m.f., then the regulation is very bad and the machines easily fall out of synchronism.

A. R.

2025. *Direct-current Engineering Practice in Germany.* **C. Brandeis.** (Elect. World and Engineer, 38. pp. 11–13, July 6, 1901.)—The great majority of German central stations use shunt-wound dynamos in conjunction with storage batteries, even for electric traction. Thirteen diagrams are given, showing various systems of working in common use; the one generally preferred for the three-wire system employs two batteries, with regulating end-cell switches next to the neutral wire, a single motor-driven booster for charging them, and the main generators coupled across the outers.

A. H. A.

ELECTRICITY WORKS AND TRACTION SYSTEMS.

2026. *East Ham Combined Lighting and Traction System.* (Tram. Rly. World, 10. pp. 333–343, July, 1901.)—This is the first municipal tramway scheme in the Metropolitan district. The length of line contemplated is 9¼ miles, of which 4¼ miles are completed. The total estimated cost for the tramways is £89,900, and for lighting £47,970. The engine room is 177 feet by 42 feet with 26 feet clear height, and is spanned by a 20-ton traveller. The boiler house is 148 feet by 46 feet and has a main flue 12 feet by 6 ft. 3 in. leading into a circular stack 9 ft. 4 in. diameter by 135 feet high. The engine room now contains one 100-kw. and three 225-kw. sets of Musgrave horizontal cross-compound engines direct coupled to the generators. The small engine has cylinders 9 inches and 18 inches, and stroke 24 inches, speed 150 r.p.m. The large engines run at 135 r.p.m. with 27 inches stroke, and cylinders 13½ inches and 27½ inches.

For traction the generators are used compound wound for 500–550 volts. For lighting they are used as shunt wound and field regulated to 480–580 volts. Two balancers, each capable of dealing with 100 amperes of out-of-balance current, are provided for the three-wire lighting mains. There are four Babcock boilers, each evaporating 10,000 lbs. per hour, fitted with Babcock superheaters. A Boby heater detarteriser is used; also a Barnard-Wheeler condensing tower and two Wheeler condensers available for any engine.

The cables are single, lead covered, by Callender. The track is laid with 87-lb. rails to standard gauge, bonded with 4/0 S.W.G. Neptune bonds. Double track is laid on a continuous bed of 6-inch cement concrete, paved to 18 inches outside rails with granite setts. Single track is laid on a similar bed of concrete 9 inches thick and paved with setts 9 inches outside each rail with tarred macadam in the centre. Sykes' patent conduit, with self-centring Stanford joints, is provided throughout under the centre of track with draw-in boxes every 100 yards. All lighting and traction feeders are carried in this conduit. The overhead trolley wire is 0 B. & S. carried on side and bracket-arm poles, the maximum length of bracket being 18 feet. Poles are 31 feet long and weigh 990–1,320 lbs. without bases. The car equipment is of standard "Short" design with two motors per car, each giving 1,000 lbs. tractive effort at 10 m.p.h. The controllers have rheostatic brakes.

E. H. C.-H.

2027. *Luton Electricity Works.* (Electrician, 47. pp. 435–437, July 12, 1901.)—This continuous-current station contains two Lancashire boilers, 30 feet by 8 feet, with superheaters; an economiser of 240 tubes; three 85-kw. dynamos; a 42-kw. balancer; a 16-kw. dynamo for charging the regulating cells; 280 chloride cells, giving 70 amperes for seven hours. The chimney is 120 feet high, with internal area of 60 square feet, and firebrick lining to a height of 40 feet. Two feeders have been laid, one 0·3 square inch, and the other 0·2 square inch in sectional area. A plan and sectional elevation of the station are given. W. H. S.

2028. *Southend Electric Tramways.* (Electrician, 47. pp. 513–515, July 26, 1901.)—About 7½ miles of track have been opened, and extensions are contemplated. The power-house contains three Economic boilers, 14 feet by 8 feet, with heating surface of 1,180 square feet. The steam main consists of a single 8-inch pipe, and besides this each engine is fed by a 4-inch pipe from one boiler. The engine-room is 84 feet long, and 45 ft. 5 in. broad, and has a 20-ton travelling crane. It contains two 200-kw. dynamos, the engines being of the vertical cross-compound type, running at 110 r.p.m., with an 8-ton flywheel; and also a similar 125-kw. set, running at 360 r.p.m. The tramway track has a gauge of 3ft. 6in.; the rails weigh 92 lbs. per yard, and sole plates of inverted rail are used at the joints. W. H. S.

2029. *Dresden Power Works.* **W. Meng.** (Elektrotechn. Zeitschr. 22. pp. 495–499, June 20, 1901.)—Dresden has three electricity stations. One in the eastern part of the town supplies 50 km. of tramways with power, and has 5,350 h.p. installed; another in the western part supplies alternate current for lighting, and has 7,600 h.p.; and the third, which is on the same site as the second, supplies power to 70 km. of tramways, and has 6,000 h.p. available. The last of these stations is described in the present article. The engine-room is 68 m. long and 20 m. broad; the boiler-house is 16 m. broad and 74 m. long. Coal is brought on a railway siding, and after passing four turntables is shot out of the trucks and conveyed by belts, elevators, &c., to the various bunkers. The bunkers hold 450,000 kg. of coal, and a subsidiary coal store holds a further 385,000 kg. At present there are sixteen boilers of the double-drum type, the one drum being placed above the other. Ten of these boilers are by Sulzberger, and have a heating surface of 112 sq. m.; the remaining six are by the Dresdener Maschinenfabrik, and have a heating surface of 120 sq. m. The chimney is 70 m. high and 3·5 m. in diameter. There are five steam dynamos, each of 1,200 h.p. One set of engines, built by the Augsburger Maschinenfabrik, has cylinders of 750 mm. and 1,150 mm. diameter by 1,400 mm. stroke; the other set, built by the Dresdener Maschinenfabrik, has cylinders of 775 mm. and 1,250 mm. diameter by 1,250 mm. stroke. The latter are slightly more economical of steam than the former, and take 5·6 kg. per i.h.p. hour on a load of 1,000 b.h.p. at 85 r.p.m., working with steam at 9½ atmospheres and a vacuum of 65 cm. The dynamos are shunt-wound, and work in parallel with buffer batteries. The Schuckert dynamos have 28 poles with a magnet bore of 5,515 mm.; the Kummer dynamos have 18 poles and a magnet bore of 5,550 mm. Various points in connection with the condensers, cooling towers, feed-water heaters, oil-filtering arrangements, &c., are described in some detail. W. H. S.

2030. *Boston Electric Supply Stations.* **E. S. Mansfield.** (Elect. World and Engineer, 37. pp. 797–822, May 18, 1901.)—*System.*—Continuous current, three-wire, at a pressure of 250 volts on the outers, with storage batteries. The plant is installed in three generating stations and three battery substations.

Station No. 1, at Head Place.—The boilers are contained in a special four-story building. On the first floor are three Whittier return tubular boilers, each with 35 square feet of grate surface; the second floor is used as an ash-room, the ashes from the boilers above being discharged through chutes; the third floor contains five Babcock and Wilcox boilers, with 56 square feet of grate surface, having a nominal capacity of 285 h.p. each. A Sturtevant fan driven by a direct-coupled engine provides these boilers with forced draught. Feed-water, from the city mains, is supplied by steam pumps and Körting injectors; it is heated to 210° F. in a Goubert heater. The fourth floor is a coal bunker of 250 tons capacity; the coal is raised by an electric elevator. The *engine-room* is on the ground floor of a separate building, and contains nineteen Armington and Sims simple non-condensing engines, each of 150 h.p. at 260 r.p.m. The cylinder diameter is 15½ inches and the stroke 15 inches. The dynamos are on the first floor, two being driven by belts from each engine. They are shunt-wound, bipolar machines of 60 kw. each, built by the Edison General Electric Company. Each pair supplies the three-wire system at 250 volts on the outers. A three-wire booster set gives 75 kw. at 750 r.p.m. The second, third, and fourth floors of the building are devoted to offices.

Station No. 2, in Hawkins Street.—This station is similar to the first, having a boiler-house, with coal-bunker above it, adjoining a three-story engine-house. The *boiler-house* contains two Babcock and Wilcox boilers of 225 h.p., two Heine safety boilers of 260 h.p., and one of 164 h.p. The *engine house* contains 12 engines driving 24 dynamos on the floor above, the machines being of the same size and make as in the first station.

Station No. 3, in Atlantic Avenue.—Full details are given of the construction of the buildings constituting this station and of its two shafts. The *boiler-room* contains seven double-deck Babcock and Wilcox boilers of 368 h.p. each, and eight of 418 h.p.; the water-heating surface in the two sizes is respectively 2,680 and 4,181 square feet. They are provided with Babcock and Wilcox chain-grate stokers, worked by electric motors.

Feed-water is supplied by steam pumps and Körting injectors; it is heated first by a Goubert exhaust heater and next by a Cochrane open heater. The *engine-house* contains four 660-h.p. engines, each driving two 200-kw. generators; one 1,200-h.p. engine, driving two 400-kw. generators; two 1,200-h.p. engines, each driving one 800-kw. generator; and two 2,400-h.p. engines, each driving one 1,600-kw. generator. The 660-h.p. engines, by the J. Morton Poole Company, are vertical, triple-expansion, condensing engines; they run at 120 r.p.m. at a pressure of 160 lbs. per square inch. The cylinder diameters are 16½, 23¾, and 38½ inches, and the stroke 30 inches. Each has a Wheeler surface-condenser and a Knowles combined circulating and air pump.

The three 1,200-h.p. vertical cross-compound engines are by McIntosh, Seymour and Co., and run at 100 r.p.m. They have reheaters of 440 square feet surface between the cylinders; the guaranteed steam consumption is 13¼ lbs. per i.h.p. hour. The cylinders are 23 and 48 inches in diameter and 48 inches stroke. Each engine exhausts into a Wheeler surface condenser.

The two 2,400-h.p. engines are of similar type, by the same firm, and run at the same speed. The cylinders are 29 and 60 inches by 56 inches stroke; the guaranteed steam consumption is 12¾ lbs. per i.h.p. hour; the reheater has 800-square feet surface. The engines are provided with turning gear driven by 5-h.p. motors. The next units to be laid down will be 4,000-h.p. engines driving 2,500-kw. generators. The travelling crane of 50 tons capacity has a span of 81 feet.

All the generators are direct-driven, and, except the first four, are built by the General Electric Company. The 200-kw. machines give 1,333 amperes at 160 volts, running at 120 r.p.m.; the 400-kw. machines give 2,857 amperes at 140, running at 100 r.p.m. The two 800-kw. dynamos supply current to the outer wires only, giving 2,666 amperes at 300 volts, or 2,963 at 270 volts; their speed is 100 r.p.m.; their commercial efficiency is, at full-load, 93·5 per cent., and at half-load 90·5 per cent. The two 1,600-kw. machines run at the same speed as the 800-kw. machines, giving double the current; one machine is arranged to give six-phase current at 184 volts and 25 ∿. There are two three-wire General Electric booster sets, each of 75 kw., giving 1,360 amperes at 55 volts.

The main switches, some for 7,000 and others for 3,500 amperes, are opened and closed by electric motors.

The cables now laid extend over 58 miles of streets. As feeders, there are 127,000 feet of Edison three-wire 1,000,000 circ. mils. tube, 145,000 feet of cable of the same size, and 35,000 feet of cable of 350,000 circ. mils. As distributors, there are 301,300 feet of Edison three-wire tube, varying in size from 200,000 to 350,000 circ. mils. The cables in use are made by the General Electric, Habirshaw, New York Safety and National Conduit and Cable Company; the insulation is mostly rubber, but some cables are paper-insulated. The cable is all drawn into conduits, varying in size from 8 to 120 ducts; two kinds of duct are in use, the cement-lined duct of the National Conduit and Cable Company and the vitrified duct of the H.B. Camp Company.

Eight storage batteries are located at the different stations. At the Head Place station are two batteries; one is a Tudor battery of 144 cells, with a discharge rate of 9,400 amperes for 1 hour, or 4,890 amperes for 8 hours; the other is a chloride battery by the Electric Storage Battery Company of Philadelphia, consisting of 150 cells and discharging at 5,600 amperes for 1 hour or 2,800 amperes for 8 hours. At the Hawkins Street station is installed a chloride battery of 140 cells, discharging at 4,000 amperes for 1 hour or 2,000 for 8 hours. At the Atlantic Avenue station are two chloride batteries of the same size as that at the Head Place station; the regulating switches are operated by electric motors, controlled by push-buttons on the switchboard. A battery station at Scotia Street contains a chloride battery of 144 cells of the same size, and a three-wire 60 kw. booster. A battery station at West Canton Street contains a Tudor battery of 144 cells, having a rate of discharge of 4,925 amperes for 1 hour, or 2,570 for 8 hours. At Pittsburgh Street is a battery of 140 chloride cells, with discharge rate of 3,040 amperes for 1 hour, or 1,520 for 8 hours. The total capacity of all the batteries amounts to 43,765 ampere-hours at a 1-hour rate or 65,647 at a 8-hours rate of discharge.

The meters used on consumers' premises are the Edison chemical and the Thomson-Houston; the Wright demand indicator is also in use. The connections to the mains are 243,800 16 c.p. lamps, or their equivalent, 2,430 arc-lamps, mostly of the Jandus type, and motors up to 100 h.p., with an aggregate of 10,400 h.p. A load diagram of the Atlantic Avenue station is reproduced. The article gives full details of all parts of the plant, and is illustrated by 58 diagrams and cuts. G. H. B.

2031. *Increasing the Pressure of Distribution at Niagara.* (Elect. World and Engineer, 38. pp. 94–95, July 20, 1901.)—The pressure at which the Niagara Falls Power Company transmits power to Buffalo has now been raised from 11,000 volts to 22,000 volts. This was contemplated at the start, and all the transformers were constructed for either 11,000 or 22,000 volts on their secondary terminals. [See Abstract No. 1193 (1900).] High-pressure circuit-breaking switches have been put in the lines before they leave the power-house. Formerly all the switching was done on the low-pressure side. These switches have a break of 4·5 feet, but this has proved insufficient, and is to be increased to 6 feet. Westinghouse "low equivalent" lightning arresters are used. As the storms are very severe, elaborate devices have been found necessary. The arrester consists first of six choking coils in series, then a 36-inch enclosed fuse of No. 28 German silver wire, and then 61 gaps between non-arcing metals, one of the gaps being adjustable. Finally, the discharge has to pass through two non-inductive coils in series of 380 and 280 ohms resistance respectively, the former being shunted by 48 gaps in series. The flow of current during a discharge through the 380-ohms coil is sufficient to create a p.d. which breaks over the 48 gaps. The adjustable gap is generally fixed at $\frac{3}{8}$ths or $\frac{1}{2}$ an inch, and the other gaps at $\frac{1}{32}$nd of an inch. The use of fuses in this kind of arrester is peculiar to the Niagara plant. A wire heavily insulated with rubber, $\frac{9}{32}$nds of an inch thick, which withstood a testing pressure of 50,000 for ten minutes, broke down after a week of continuous service at 22,000 volts. It is suggested that this was due to the continuous brush discharge from the wire at certain points generating sufficient ozone to rapidly deteriorate the rubber. A number of insulators on the line have proved too weak for the higher voltage. These are weeded out by patrolling the line at night and noting the burning pins. Repairs are made in the daytime when the current is off the line. Interesting photographs are given of a 22,000-volt ammeter panel, and also of the high-pressure bus-bar arrangements. A. R.

2032. *Distribution of Energy at Buffalo.* **H. G. Stott.** (Amer. Inst. Elect. Engin., Trans. 18. pp. 237–264, April; Discussion, pp. 381–391, June, 1901. Also Elect. World and Engineer, 37. pp. 516–519, March 30, 1901.)—The author gives much important information concerning the detail work of distributing power from the Niagara Falls in the city of Buffalo. [See also Abstracts Nos. 1192 and 1193 (1900).] Various types of high-tension switches and circuit-breakers are described; for the details the original paper should be consulted. The five cables for distributing power at 11,000 volts from the main station in Buffalo have each of them three conductors, of 000 B. & S. gauge. Three of these cables are insulated with a wall of rubber mixture $\frac{9}{32}$ inch thick, having 30 per cent. pure Para rubber; one has a wall of $\frac{1}{4}$ inch rubber mixture with 40 per cent. pure Para rubber; and the fifth has on each conductor $\frac{13}{64}$ inch of paper, and around the three insulated conductors an additional belt of $\frac{13}{64}$ inch of paper. The three insulated cables are twisted into a rope, and the interstices filled with jute yarn, to give an even surface for the lead, which is $\frac{1}{8}$ inch thick. The outside diameters of the cables are approximately $2\frac{3}{8}$ inches for the rubber and $2\frac{3}{8}$ inches for the paper cables. Experience shows that the first three cables are good for 11,000 volts; the fourth apparently is not; while the paper cables have been laid too recently for any conclusions to be possible. In the discussion some of the speakers drew attention, from the manufacturing point of view, to the figures given for the insulation of rubber cables. The author, however, stated that an extra thickness of $\frac{1}{32}$ inch of insulation had greatly decreased the number of breakdowns. He stated that tests were being made with a view to finding out what deterioration of insulation took place under continued high pressure. If at the end of ten days the insulation resistance is 400 megohms, at the end of twenty days it may be down to half that value, and keep on decreasing. The decrease in the case of pure rubber appears to be more marked than in the case of less pure rubber, but the tests are as yet incomplete. In the runs of the various cables above mentioned, oil switches are placed about a mile apart in water-tight iron boxes for the purpose of isolating a defective length. The cables are looped and not tapped into the substations; this enables cross-connections to be made in case of a failure. The largest user of power is the International Traction Company, which receives 7,000 h.p. at 11,000 volts, and transforms by rotary converters to 600-volt direct current. The author states that for 200-kw. units the efficiency of rotary converters and static transformers combined is 8·27 per cent. higher than that of synchronous motor-generators at full load. Moreover, they are about 19 per cent. cheaper. Figures are also given comparing the efficiencies at other loads, at half-load the rotaries having an advantage of 5 per cent. For railroad work, "where no great refinement of regulation is required, the rotary is beyond doubt the best and most economical." There is also a large substation where current is supplied to the Buffalo General Electric Company, and by them converted and distributed in a variety of ways. They undertake the street arc-lighting; for this purpose the present method adopted is to use 14 motor-generator sets, each consisting of a 150-kw. synchronous motor coupled to two 125-light 9·6-ampere Brush arc generators. They also distribute 60-cycle current for incandescent lighting by means of synchronous motor-generators, the generators giving current at 2,200 volts. The difficulties involved in synchronising these machines were rather unusual, owing to the fact that the motors had 8 poles and the generators 20. These were partly overcome by the insertion of a reversing field switch on the motor, which caused it to slip a pole on each reversal. Other precautions had to be adopted in the matter of excitation to ensure that the two machines, when paralleled, should properly divide the load.

Discussion.—The question was raised as to the applicability of three-phase current to traction work. **Steinmetz** said that he had started testing a three-phase trolley-car in 1894; he considered the three-phase motor decidedly inferior in starting, and in running at low speed, and in acceleration, to the continuous-current series motor. The motor is in its electrical and mechanical character essentially a shunt motor. At starting, the same current is required for a given torque as is required at full speed; the rest of the power corresponding to the reduced speed is merely wasted in the rheostat. The power factor of induction motors would be much decreased in practice, owing to the necessity of using motors with large air-gaps for mechanical reasons. This would increase the reactance drop on the line, and might cause such a fall in voltage that the induction motor, the torque of which is proportional to the square of the voltage, might not start at all. Moreover, even at 20 cycles, the ordinary iron rail offers against an alternating current an impedance which is from three to five times the ohmic resistance. Regarding circuit-breaking devices, he pointed out that a break in air is essentially a quick break. Metal vapour can draw an arc two or three feet long, having a drop of not more than a few hundred volts across the arc; but when the break takes place, it is extremely quick. With an oil switch the break is not a quick break. Liquid is practically incompressible; the gas bubble which is formed stands under enormous pressure, and holds the arc up to the next zero value of the current, when the liquid pressure blows out the arc. In all inductive circuits with negligible capacity the air switch is more dangerous than the oil switch; and this is probably true generally. W. H. S.

2033. *Spanning Carquinez Straits with a High Potential Transmission Line.* **R. H. Sterling.** (Elect. World and Engineer, 37. pp. 963–966, June 8, 1901.)—This paper contains a general description of the method adopted by the Pacific Construction Company of San Francisco in the construction of an aerial cable across these straits, to be worked at a pressure of 60,000 volts. The channel is 3,200 feet wide, and Government requirements called for a clearance of 200 feet above high water, which, with the sag of 100 feet allowed, necessitated the construction of towers 65 feet and 225 feet in height respectively. The span between the supporting towers is 4,427 feet. A wind pressure of 75 miles an hour had to be provided against. The cable employed was a stranded steel wire ⅞ inch in diameter with a breaking strain of 98,000 lbs., the total weight of each span being 7,080 lbs. The tension on the cable when *in situ* was such as to allow a factor of safety of 4. Cast-iron saddles on wooden platforms and porcelain insulators take the cables on top of the towers, the ends being fastened to "strain insulators," of which the draw-bars are insulated from the steel yokes by micanite and an oil chamber, with a porcelain sleeve in paraffin to prevent creeping. Two strain insulators are used in series. Four cables are suspended, one being a reserve to the three-phase system employed. The author notes that when a cable is switched out for repairs it must first be earthed, as the static effect is great. The strain insulators and anchorages are protected by enclosing shelters. The paper is illustrated with detail drawings and photo blocks of the two types of insulator employed.

A very complete account, with drawings and illustrations, also appeared in the Journal of Electricity S.F., May, 1901. B. P. S.

2034. *The Kensington and Notting Hill Companies' Joint Electricity Supply Works.* (Electrician, 47. pp. 738–743, Sept. 6; 779–781, Sept. 13; and pp. 818–820, Sept. 20, 1901.)—The station, which has been erected by the two Companies for the supply of energy to their already existing systems, is situated at Shepherd's Bush, and immediately adjoins the station of the Central London Railway Company. It is at some distance from the areas to be supplied, and therefore the three-phase alternating-current system was selected. This is to be converted to continuous current by means of asynchronous motor-generators, each of the two Companies making its own arrangements for this conversion. The site of the power station adjoins several railways, from which extensive sidings have been constructed, amounting in all to a length of 1,400 feet. Both the boiler-house and engine-room are 126 feet long by 45 feet wide, the 20-ton travelling crane being 28 ft. 6 in. above the level of the engine-room floor. The chimney is 230 feet high and 11 feet in diameter; it stands on a concrete block 36 feet square and 10 feet thick. The firebrick lining is carried up to a height of 40 feet from the bottom. The lightning conductor consists of two copper bands 1¼ inches by ⅛ inch, terminating in four copper earth-plates, and round the top of the cap there are six gold-plated copper points with a copper ring. The boiler-house contains at present five boilers, each having a heating surface of 3,654 square feet, working at a pressure of 200 lbs.; they are fitted with chain-grate stokers. The main flues are in duplicate, and each contains a 320-tube economiser. The coal and ash handling plant is described in detail. It was constructed by Graham, Morton & Co., of Leeds. The coal is first raised by an elevator through a height of 75 feet, and is then distributed by a push-plate conveyor to the various bunkers. These bunkers are placed above the boilers, and are 108 feet long, 17 feet wide, and 17 feet deep, being capable of storing 800 tons of coal. From the bunkers the coal is fed into the boilers by means of shutes. The whole plant is designed to deal with 30 tons of coal per hour. Over the boilers are two cast-iron water tanks, holding 55,000 gallons of water. They measure 112 feet by 16 feet by 6 feet, and are placed at such a height that they give the head of water required by the ejector condensers fitted on the engines. The steam pumps are six in number, and are of the Karoome type; three are feed pumps, having a capacity of 4,000 gallons per hour; and three are low pressure pumps, dealing with 100,000 gallons per hour against a 35-feet head. A cooling pond, working on the jet system, has been constructed; it measures 100 feet by 60 feet by 7 feet. The main steam-pipe is 7 inches in diameter; the T-pieces are of wrought steel riveted to the pipes. The engine-room contains at present five steam alternators. Of these, three have a capacity of 330 kw., running at 300 r.p.m., and two others generate 550 kw., running at 270 r.p.m., the voltage being 5,250, and the frequency 45. The engines are by Willans, and the alternators by the Oerlikon Company. The engines are of the three-crank triple-expansion type, and each is fitted with a Koerting ejector condenser. The engine cylinders are lubricated by a mixture of graphite and cylinder oil, which forms a thick paste, one drop per minute being fed into the engine cylinder. The generators are of the inductor type and give three-phase current. In the case of the smaller machines, the inductor is 1,814 mm. in diameter, and the clearance between rotor and stator is 3 mm. The exciting current is provided either by exciters, or a motor-generator, or by a battery, the latter consisting of 56 cells, having a capacity of 600 ampere-hours. The cells and the motor-generator are used for working auxiliary motors in the station and also for lighting purposes. The switchboards are in five separate sections; the first panels are for the exciters, cells, &c.; the second for the smaller alternators and the motor-generator; the third for the trunk mains to the Notting Hill Company's district; the fourth for the larger alternators; and the fifth for the trunk mains to the Kensington Company's area. Care has been taken to make the switchboard as safe as possible. All working parts are placed behind the board, each panel having a cage of iron wire-work behind it, the door of which is closed with a Yale lock. In case anything should require adjustment, the engineer-in-charge has to cut off the current from the panel by means of the main switch, and lock it with a Yale lock, after which access is possible to the cage at the back of the panel in question. In this way, no parts carrying high-tension current are exposed on the front of the board, the main switches being operated from the front, but having their working parts at the back of the board, and at a considerable height above the floor level. The feeders to the sub-stations are all composed of conductors having a section of 0·15 square inch, and are in all cases connected to asynchronous motor-generators. The Kensington Company has a sub-station behind the Albert Hall, containing one 100-kw., two 180-kw., and three 200-kw. machines. Motor-generators have also been placed in the Kensington Court Station. The Notting Hill Company has a substation on the site of their main station in the High Street, Notting Hill, and also another in Lancaster Road. The first contains two 60-kw., two 180-kw., and one 300-kw. motor-generator; while the second has one 100-kw., and one 180-kw. sets. All the machines run at speeds between 380 r.p.m. and 420 r.p.m. The main power-house at Shepherd's Bush contains the usual workshops; into these a railway siding is brought, and a 10-ton overhead traveller is provided for the purpose of unloading and handling machinery. There is also a complete set of apparatus for testing coal, and for carrying out boiler trials. The article contains several drawings, showing plan and section of the generating station, the general arrangements of the switchboards at Shepherd's Bush and at the Lancaster Road substation, and also the general construction of the alternators; in addition, there are illustrations of the coal-handling appliances, and of several points in connection with the switchboards. W. H. S.

ELECTRIC TRACTION AND AUTOMOBILISM.[1]

2035. *Electric Railways.* **P. Cardew.** (Soc. Arts, Journ. 49. pp. 641–651, July 12; 653–662, July 19; and 665–674, July 26, 1901.)—On tramcars the use of gearing is universal; on trains the best method of driving is still doubtful. One of the most hopeful proposals is that of Ganz, who mounts the motor armature on a hollow cylindrical axis normally concentric with the solid axle of the wheels, but carried by the underframe of the motor car, which is spring-supported in the usual way. The hollow axle has three projections symmetrically disposed, to two of which connecting rods are attached, while the third is for balancing. The connecting rods are attached at their other ends to bell cranks pivoted on spokes of the driving wheel, and these bell cranks are connected by a third rod. The whole jointed system transmits the torque from the hollow axle to the wheels, while allowing considerable relative motion vertically between the two axles.

The second lecture deals with the polyphase system and describes the form installed by Ganz on the Lecco-Colico lines and proposed for the London Underground. The "cascade connection" consists in joining the rotor of the main motor to the stator of a second motor. The large rotor then generates currents in the small stator at a frequency proportioned to the slip, *i.e.*, starting at the frequency of supply and becoming slower as the motors speed up. If the small rotor is connected to an external resistance it will generate current at a frequency proportional to its slip. If the motors are mechanically connected (as in the Ganz system), and if the common speed at which they must move is one-half the synchronous speed for the large motor, then the slip of the large motor is 50 per cent., the frequency of the current supplied by it to the second motor is one-half that of the supply current, and the slip of the small motor is zero. Two motors thus coupled tend to a limit of half speed, like two continuous-current motors in series, except that in the latter case each motor receives half the energy directly from the supply, whereas in the former case the whole energy is taken by the stator of the first motor and transmitted inductively to its rotor, which applies one half mechanically to the axle, and transmits the other half electrically to the second motor.

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[1] Non-electrical Automobiles are described in the section dealing with steam and gas engines.

To accelerate from half to full speed it is not practicable to put the two motors in parallel, but a rheostat is substituted for the small motor. With Ganz's arrangement, considering merely the acceleration of the mass of a train, the maximum power taken is proportional to the rate of acceleration and the maximum speed required. Also the total energy required varies as the square of the speed attained, and is independent of the acceleration.

With the cascade arrangement, braking action with return of energy to the line is available from full speed down to nearly half speed. The amount of energy returned is about 16 per cent. of that used for acceleration on the level, or about 30 per cent. of the kinetic energy of the train, thus making the efficiency of the system undoubtedly greater than is obtainable with the series-wound continuous-current motor.

Low frequency is found advisable with the cascade system. Ganz uses 15 periods and proposes to avoid difficulty with blinking lights by using a three-filament lamp, so that the average brilliancy of the three filaments is constant.

The control in the Ganz system is all effected by compressed air, to avoid dangers of shock. The rheostat is cut in and out by compressed air controlled by an automatic valve, which can be set for a predetermined rate of acceleration. The rheostat consists of iron plates up which alkaline solution is forced, the plates being so shaped that the immersed surface rapidly increases as the liquid rises: this maintains the starting torque uniform up to full speed.

The compressed air system allows the control of several pairs of motors from one end of the train on the multiple-unit system.

The third lecture deals with generation and transmission, discusses the relative advantages of continuous and polyphase current, and works out the traffic arrangements, equipment, and cost of a railway which might advantageously adopt electric traction. The lines consist of two Metropolitan termini serving one main line, with local loops at the Metropolitan end and branches at the seaside end, 50 miles from London. E. H. C.-H.

2036. *Graphical Solution of Electric Traction Problems.* **G. Brandt.** (Elektrotechn. Zeitschr. 22. pp. 514–515, June 20, 1901.)—A letter criticising Pforr's paper [Abstract No. 1844 (1901)] on this subject. The author is of

opinion that the apparent simplicity of some of Pforr's diagrams is due to his having made assumptions which are not fulfilled in practice; and that if all the conditions of practical working were taken into consideration, the graphical method would in general be much too complicated to be of value.
A. H.

2037. *Trolley and Bow Collectors.* **R. Philippe.** (Génie Civil, 38. p. 225, 1901.)—This paper compares the advantages of the trolley and bow forms of collectors for tramways. Some forms of bows are illustrated: a brass bar, covered with white metal, lasts about a fortnight; when provided with a groove containing grease its life is from six weeks to two months. One form shown consists of two U-section aluminium channels placed one inside the other; the interspace is filled with grease and the centre channel with white metal. The triangular form of bow with lateral flexibility is recommended, as this regains its proper position if it escapes from the trolley wire without breaking contact. The bow is not liable to jump off the trolley wire at crossings and curves, and allows greater latitude in the overhead construction than the trolley.

The pressure of the bow against the trolley wire need not exceed three to five kilos, while the trolley requires a greater pressure to prevent jumping. The wear on the trolley wire with a bow collector flattens the lower surface; as the rubbing surface increases the pressure per unit of surface, and consequently the wear, diminishes. After four years the wear on an 8 mm. wire amounted to only 5 per cent. The wear occasioned by a trolley wheel is considerably more, and is chiefly on the sides of the wire. G. H. B.

2038. *Methods of Safety for Overhead Systems.* **E. Manville.** (Tram. Rly. World, 10. pp. 372-375, July, 1901. Paper read before the Association of Municipal and County Engineers, at Leicester, June, 1901.)—Formerly 0 B. & S. trolley wire was used, breaking at 4,560 lbs.; this occasionally parted, and a gradual strengthening of overhead construction has taken place, till 000 wire is now the best practice. This stands a strain of 6,580 lbs. Guard wires should be of galvanised steel not less than ⅜ inch diameter, supported substantially. The latest Post-office regulations describe a good arrangement, and are discussed by the author in detail.

Stops on the trolley arm make it difficult to foul the guard wires; but if this does happen the trolley head is almost certain to be torn off. Hence the trolley pole should be long enough to allow the head to fall clear of the car. All metal parts of the car should be carefully earthed to avoid shocks.

Devices to ensure safety in the event of breakdown are either (i) automatic switches requiring a pilot wire for each section of trolley wire, carried the whole length of the ½-mile section; or (ii) mechanical devices. The best of the former is the "Quin" switch, which involves isolating adjacent sections of trolley wire, and also necessitates hand operation of the switches in each pillar after supply has been cut off by accident or at night. The mechanical device usually consists of a short weighted lever, which drops into contact with the bracket arm or other "earth" in the event of fracture of the trolley wire. E. H. C.-H.

2039. *Friction of Brake Shoes.* **R. A. Parke.** (Railroad Gazette, 33. pp. 404–408, June 14, and 435–438, June 21, 1901.)—The old law that friction between two surfaces is merely proportional to the force with which they are pressed together, and is increased by adhesion at rest and decreased by lubrication, was proved inadequate by the Westinghouse-Galton experiments in 1878. The conclusions from these were admittedly limited, but further experiments were not published till a paper was read before the Western Railway Club in September, 1900, based on experiments with the Master Car Builders' brake-shoe testing machine. This paper concluded that—

(i) The coefficient of friction decreases as the pressure increases, within the limits of the tests.

(ii) The coefficient decreases with increase of speed, except from ten to twenty miles per hour, between which points it slightly increases.

(iii) The coefficient is generally nearly constant from shortly after the start till just before the stop, when it rises from 1½ times to twice the average value.

The author criticises each of these conclusions at length, agreeing with (i) which falls in with the idea of friction being due to the irregularities of the two surfaces being more or less interlocked according to the pressure. Conclusion (ii) he considers wrong, being founded on a comparison of the values of the "mean" coefficient of friction during stops made from various initial speeds. This mean coefficient bears somewhat the same relation to the actual that the mean effective pressure of a steam diagram does to the actual pressure at any moment. He considers that the relation is of the form—

$$f' = \frac{a}{1 + bV};$$

where f' = coeff. of friction, V = speed, and a and b are constants for the materials and conditions. Conclusion (iii) should rather read: "In an application, during which a uniform speed is constantly maintained, the line representing coefficient of friction rises quickly to a maximum, and then immediately declines with a continually decreasing rapidity, until it reaches a certain level (considerably below the initial maximum), at which it thereafter remains practically constant."

Further criticism is made of temperature observations, which were not taken at the surface of the shoes, and are therefore worthless, owing to varying rates of conduction.

The second part of the article deals at length with the nature and scope of desirable experiments on the subject. E. H. C.-H.

2040. *Brakes for Electric Tramcars.* **A. L. C. Fell.** (Elect. Rev. 49. pp. 120–121, July 19, 1901. Paper read before the Municipal Electrical Association at Glasgow.)—The author describes and criticises the various forms of brake. For general purposes, the hand-brake worked in conjunction with the slipper-brake gives the best results. The author considers that the "Corning" brake-shoe is the best; it is more expensive than the ordinary cast-iron shoe, but lasts much longer, without materially affecting the wear and tear on the wheels. A Corning shoe was shown to the Association, which had run over 12,500 miles on a route where the gradients reached 1 in 11, and would have easily lasted over another 1,000 miles. Ordinary cast-iron shoes over this route ordinarily last for 6,000 miles. Fricton-plate brakes are simple and effective, but are not much used owing to their taking up too much space. Slipper-brakes constitute a most useful type, consisting of wood blocks pressed on the rails by levers, and they should be used on all gradients steeper than 1 in 20, the best results being obtained when they are used in combination with a hand or electric brake. Pneumatic brakes are both complicated and unsatisfactory; the dust which is drawn in with the air cuts up the cylinder of the compressor, and there are points in connection with the design and working of the apparatus which require further attention. There are also various forms of magnetic brake, including the Newell, which is a form of slipper-brake, giving satisfactory results under test. Another form consists of two cast-iron discs, one keyed to the axle and the other to the motor spindle. The latter disc has a coil wound round it, through which the motor is gradually short-circuited. This brake is liable to cause the wheels to skid, and should not be used in conjunction with a hand-brake. On a good rail, it can be used for taking a car down a gradient of 1 in 11, but it is safer to use a slipper-brake as an auxiliary. Electromagnetic brakes are expensive; the wear and tear is excessive; moreover, if the gradients are steep, the life of the motors may be appreciably shortened, if the electric brake is constantly used, as the motors never get an opportunity of cooling down. Some figures are given showing results obtained with the different forms of brake.

W. H. S.

2041. *Signalling on Outlying Siding Connections.* **A. W. Szlumper.** (Inst. Civil Engin., Proc. 144. pp. 11–15; Discussion, pp. 23–42, June, 1901.)—Between two block-section boxes the lever working the siding-points may be fitted with a lock which can only be operated by a tablet obtained from the tablet-instrument in the section-box, the absence of a tablet from this box effectually blocking the line until it is either returned or taken to the next section-box in advance. Another device is an Annett key in the section-box, the removal of which locks the tablet-instrument and the starting signal: it is then taken by the shunter to the siding, and is used to unlock the lever working the points. While the key is absent no trains can be received or sent on this particular section. For siding-connections with a double line without a cross-over the old system was a ground frame with three levers working points and outdoor signals, home and distant, with no control by the section-boxes. An improved method for a siding-connection without a cross-over road for the Sykes "lock-and-block" system, is a combination of an Annett key and a Sykes block-instrument. For shunting operations at the intermediate siding one of these keys must be taken out. But it cannot be removed until the home and distant signals are at danger, and, further, to release a key in one section-box the signalman at the other box must plunge his instrument. The removal of the key breaks down the block instrument until the key is replaced at one or other section-box. No outdoor signals for the siding are required.

Another satisfactory method is to have a ground frame-box and outdoor signals at the siding. An electrical locking-instrument is fitted in both the section- and the siding-boxes. The shunter first opens a cupboard on the outside of his box where there is a bell, using an ordinary carriage key, and sends a bell warning: the signalman at the section-box with a small lever unlocks the instrument at the siding, removes the lock in the distant signal lever tappet, and unbolts the cabin door. When operations are over this door is again closed, and a handle attached to the locking-rod, which can be got at through the cupboard, is raised, restoring the normal arrangements and plunging and freeing the instrument in the section-box. Everything being locked up in the cabin the apparatus cannot be tampered with. If there is a cross-over a switch is provided at the siding which is turned after the bell-warning is sent. If the section is clear the push in the section-box is held in, freeing the locking instrument at the siding, raising the lock from the tappet on the distant signal lever and sliding the block switch to the "in" position. The siding-box is now switched in as a section-box, and shunting operations proceed. This plan is used on the L.S.W.R. In the discussion, **A. T. Blackall** suggested additional protection by home and distant signals worked from the ground-frame in the improved scheme for a siding-connection without a cross-over road. **A. W. Szlumper** called attention to the fact that the electric lock-and-block system, combining the block instruments with the outdoor signals is being largely adopted. But in case part of a train should break away, the line is fouled, although the front part works the treadle and clears the line. The mechanism can be fixed to the last car, but in the case of goods trains this cannot be always in place. The alternative seems to be the track-circuit as used in America, which means a continuous treadle. Wheels with wooden centres would not, however, cause the necessary short-circuit. **F. E. Robertson** proposed in such cases to fix a wire from the box of the wheel to the tyre, and **A. H. Johnson** remarked that it would not be necessary to wire all the wheels: the engine has iron wheels: those of the guard's van would have to be wired: a strip of metal could be used. In the United States all signals were being worked automatically. The electro-pneumatic system was seen to great advantage in large yards, such as Boston, St. Louis, Pittsburg, or Philadelphia. There was one installation on the G.E.R. in England, but it did not do the system justice. **W. J. Griffiths** had installed the last named at Whitechapel, but there was no scope there for speed and no fixed time-table, the up-road and down-road being at times subject to shunting from one to the other. Still the system enabled 15 per cent. more trains to be handled than formerly at the busiest hour of the day. **W. S. Boult** proposed to have magnetic indicators and bells on the engines themselves, so that both the driver and fireman can read the signals and no look-out ahead need be kept. He would place magnets at desired positions on the road which would actuate "armature-relays" on the engines as the latter passed these positions. **F. W. Webb** and **W. H. Preece** alluded to the system of electrical points and signals now being introduced at Crewe. One of the main-line junctions had been working with great success. One box for controlling the north end of Crewe Station will have 300 levers. The station would be nearly four miles in length. There will be a central power-station to do all the electric lock-and-block work, lighting, and perhaps some heating. The points are brought over by motors placed underground. There would be additional security, greater speed, and capacity for dealing with more traffic. E. O. W.

2042. *Signalling on the Waterloo and City Railway.* **A. W. Szlumper.** (Inst. Civil Engin., Proc. 144. pp. 1–10; Discussion, pp. 23–42, June, 1901.)—There are two signal-boxes, one at Waterloo and the other at the City, the former containing 16 levers, and the latter 18. Each line is practically divided into two block sections by intermediate signals fixed about half-way between the two stations, and controlled electrically from both boxes. Between the points and signals, ordinary mechanical locking obtains, but between the signals and treadles Sykes electric interlocking exists, the trains controlling the signals. The levers and tappets are of ordinary pattern. If a train is to start from Waterloo for the City, (1) a warning-bell signal is sent to City; (2) at the City, if certain treadles are in normal condition, that is, if no train is operating them, and the lever therefore not electrically locked, No. 16 lever (up-line "stop" or "home" signal) is pulled ; (3) the City block-instrument is then plunged ; (4) No. 2 lever at Waterloo is thus released ; (5) the movement of No. 16 lever at the City has set up a current to the City up distant signal ; (6) No. 2 lever being worked at Waterloo the circuit just referred to is completed ; (7) at Waterloo the advance starting signal is lowered, setting up a current through a "selector" on the starting signal, and either the "right away," or "shunt by" arms can now be obtained, subject to the conditions of the treadles on the section beyond the advance starting signal ; (8) if this signal can be lowered the "right away" can be given ; (9) the train starts and No. 3 lever (starting signal) is back-locked until the train has passed a bar outside the platform ; (10) the train clears that bar and the lever is restored to its normal condition and becomes electrically locked until the train passes a bar which is beyond the advance signal ; (11) this movement releases the lock in No. 2 lever, which enables it to be restored ; (12) lever No. 3 can now be worked again for lowering the "shunt by" arm on the starting signal, which permits a a second train to leave Waterloo and to travel as far as the advance starting signal ; (13) on arrival of the first train at the City up-platform No. 16 lever is restored. If the signalman at Waterloo requires to put the starting signal back to danger before the train has started, he can do so by working the lever three-quarters back, when the signal goes to danger. This does not affect the electric lock : all signal levers are so arranged. Supposing that a driver should endeavour to pass a signal at danger, a slipper bar cuts off the current from the motor and the train, therefore, is unable to proceed.

E. O. W.

2043. *Signalling on the Liverpool Overhead Railway.* **S. B. Cottrell.** (Inst. Civil Engin., Proc. 144. pp. 16–22 ; Discussion, pp. 23–42, June, 1901.) —An electrically worked line 6¾ miles in length, 2 terminal and 15 intermediate stations, and 2 junctions in connection with the carriage-sheds, workshops, &c. There are mechanical signals at the termini and junctions, and Timmis's automatic system at the intermediate stations. This arrangement was estimated to be the least costly. At the intermediate stations there are the usual semaphore and spectacles, with a fixed Timmis's long pull magnet one-third of the way up the post. This operates the arm, and a dead-weight brings it to danger when the circuit is broken. Under the signal are two "breaking" contacts coupled in series, so that one at least will act, and 1½ train-lengths ahead is the "making" contact, also in duplicate. A train on leaving a station passes the former, and the last coach puts the starting signal to "danger," then passes the latter, which pulls off the home signal of the station it has just left and the starting signal of the station in the rear. When the armature of any signal magnet is pulled down by current from the station in advance, before the circuit is broken another contact is made bringing in the holding-off circuit. This latter is supplied from a battery at the station where the signal is situated ; in this circuit which passes through the "breaking" contact a high resistance is inserted which reduces the current from 5 to 0·25 ampere. The magnet with 5 amperes will raise a weight of 56 lbs. at a distance of 2 inches. Accumulators for 50 volts work the signals. The expenditure of electric energy is very small. As the stations are very near together there are only 4 signals at each—2 home, and 2 starting—the latter being practically the distant signal for the station in advance. This protects the train, and if it fails to go to "danger" a simple dead-weight switch will not come into play, the result being that there will be an absolute block on the section in rear.

Discussion.—**W. J. Griffiths** alluded to an accident on the Paris Metropolitan Railway, where vehicles broke away and ran back. The striker in use on the Liverpool Overhead Railway would not meet this difficulty, and there might be no time to stop a following train. **F. W. Webb** also mentioned a case in Paris where an electric engine failed on an ascent, ran back, and liberated a signal in the rear; the following train then ran into that in advance. He gathered that at Liverpool a train could be set back to a certain extent without danger. **W. H. Preece** said that for an absolute block, the signal must not only be at danger behind a train, but the section behind must be *dead*. No train could then move in that section, as there would be no current. This had not been done at Liverpool because the trains were so near to each other. He thought that it would be advisable on the London Metropolitan. **A. W. Szlumper** said that *dead* sections were practically constituted in the Waterloo and City Railway in the fact that the slipper-bars cut off electricity from the motors if a train approached within a few yards of a signal when it stood at "danger." E. O. W.

ELECTRIC LAMPS AND LIGHTING.

2044. *Photometric Tests of Arc Lamps.* (Elect. World and Engineer, 37. pp. 894–897, May 25, 1901. Paper read before the National Electric Light Association. See also Abstract No. 2347, 1900.)—The report of **C. P. Mathews** is continued. Tests were made on various samples of carbon in 110-volt alternating-current enclosed arc lamps, and the results are given in the form of life curves and tables. The average consumption was about 6 inches with a life of about 100 hours and a luminous intensity of about 220 Hefner units. Series direct-current enclosed arcs were tested, taking 6·8 amperes at 70 volts and giving a mean hemispherical intensity of about 330 h.u. An alternate-current series enclosed arc gave similar results. The tests are being continued. A. H. A.

2045. *Arc Lamps.* **A. Bochet.** (Soc. Int. Élect., Bull. 1. pp. 298–306; Discussion, pp. 306–311, June, 1901.)—This paper deals with low voltage alternate-current enclosed arc lamps from 35 to 38 volts, and those of medium voltage, from 38 to 50 volts. It gives the size of carbons best employed with different currents on the different voltages. Remarks are made on the controlling mechanism of arc-lamps, and the author advises when three lamps are in series on a constant voltage, that one differential lamp shall be used to keep the current constant, the other two lamps being furnished with shunt electromagnets, keeping the difference of potential constant in each arc. In the air dash-pots of lamps it is advisable to insert valves so as to allow the air to enter when the carbons approach, or to allow the piston-rod a certain amount of play in the piston, thus enabling the carbons to come together more rapidly at the commencement of their movement towards each other when the lamp feeds. In alternating lamps it is advisable to employ regulators in which the displacement of the cores in the regulating bobbins is as small as possible, so as to keep the self-inductance of the lamp as constant as possible.

In the discussion, **A. Lecomte** read a note on enclosed arc lamps. E. C. R.

2046. *Continuous-current Electric Arcs.* **P. Janet,** with **F. Laporte** and **C. Léonard.** (Soc. Int. Élect., Bull. 1. pp. 251–296; Discussion, pp. 306–311, June, 1901.)—This paper gives the results of experiments carried out at the "Laboratoire Central d'Electricité," on the photometry of the direct-current arc. The photometric measurements were taken by means of a Blondel "lumenmeter." In this instrument the arc is in the centre of an opaque sphere, out of which are cut two sectors having an angle of 18° each; consequently one-tenth of the total luminous flux escapes by these openings from the sphere, and this falling on a mirror of elliptical section, is reflected and concentrated on a white screen about 8 metres distant. This screen is taken as a luminous source, and illuminates the screen of a photometer placed before it and at a fixed distance from it. This illumination is balanced by moving a glow-lamp of known candle-power on the other side of the photometer screen. The paper is illustrated by curves giving the relations between the total flux in lumens and the volts in the arc for different currents, the total flux and the amperes for different volts, curves of equal luminous fluxes, with volts and amperes as co-ordinates, curve of constant power in watts with volts and lumens per watt as co-ordinates. Also curves of the consumption of the carbons are given. The influence of the diameters of the carbons on the luminous flux is discussed theoretically, and the results of experimental determinations given. Finally, experiments on the luminous flux produced by two or three lamps in series on a 110-volt supply are described. In this case, with the current at 8 amperes, the potential difference per lamp was 33 and 43 volts, the luminous flux per lamp 2,800 and 3,900 lumens, and the total luminous fluxes 8,400 and 7,800 for three and two lamps in series respectively. E. C. R.

REFERENCES.

2047. *Storage Battery Boosters.* **L. Lyndon.** (Elect. World and Engineer, 37. pp. 972–974, June 8; 1015–1017, June 15; 1071–1073, June 22; 1112–1113, June 29; 38. pp. 13–14, July 6; and 64–65, July 13, 1901.)—These articles give an account of the various methods of employing storage batteries in lighting and traction systems for the purpose of smoothing out the current fluctuations and equalising the load on the generators. They are classified into "floating batteries"—*i.e.*, simple parallel connection across the mains—shunt, series, compound, differential and constant current boosters. In each case the most suitable conditions for the application of the method are indicated; algebraical formulæ are worked out for determining the size of the booster dynamo, best number of cells and so forth; and diagrams of the connections are given. E. J. W.

2048. *Storage Batteries in Power Stations.* **L. Lyndon.** (Street Rly. Journ. 18. pp. 18–22, July, 1901.)—This article deals with the use of accumulators as—(1) a reserve to store energy during light load and discharge on the "peaks"; (2) a regulator to absorb or compensate for rapid fluctuations of current demand; (3) a regulator on a long feeder-supplying receiving apparatus so as to maintain at all times a uniform voltage at the terminals of the receiver. Curves and data are given to assist in determining the best size of battery, taking into account its cost (including boosting machinery) as against that of the generating plant which would otherwise be required. The method of arriving at the comparative operating costs is considered: also the most suitable types of booster machines to be used. E. J. W.

2049. *Electric Underground Railways.* **J. Lowy.** (Zeitschr. Elektrotechn. Wien, 19. pp. 284–288 ; Discussion, p. 288, June 9, 1901. Paper read before the Elektrotechn. Verein, Wien, Jan. 30, 1901.)—It deals generally with the problems presented by the working of underground railways electrically, and gives statistics, of the fourteen underground railways which are at present in use. E. K. S.

2050. *Financial Aspects of Electrical Supply.* **W. A. Chamen.** (Electrician, 47. pp. 327–329, June 21, 1901.)—Presidential address to the Incorporated Municipal Electrical Association.

2051. *Electrical Installation in Paper-works.* **A. D. Adams.** (Elect. World and Engineer, 37. pp. 1101–1103, June 29, 1901.)—A description of a water-power installation at Millinocket, Maine.

2052. *High-Tension Traction.* **F. Koromzay.** (Assoc. Ing. Él. Liège, Bull. 1. pp. 138–163, July 6, 1901.)—This article contains a statement of the arguments advanced in favour of the so-called Ganz system of supplying high-tension polyphase current to motors carried on the train. The matter herein contained is very similar to that of the paper which has been already noticed in Abstract No. 464 (1901). W. H. S.

2053. *Electric Railways.* **M. Schiemann.** (Elektrotechn. Zeitschr. 22. pp. 595–598, July 25, 1901. Paper read before a meeting of the Verband Deutscher Elektrotechniker at Dresden.)—The author gives a general outline of some Continental schemes which are either under consideration or construction. He also deals generally with the various methods by which high-tension current can be applied to such schemes. W. H. S.

2054. *Cost of Power for Tramways.* **W. H. Tittensor.** (Electrician, 47. pp. 488–489, July 19, 1901. Paper read before the Municipal Electrical Association at Glasgow.)—A discussion of the question as to the price to be charged for energy supplied to tramways from a station providing power both for lighting and traction. W. H S.

2055. *Overhead Low-Tension Distributing Systems.* **Bönninghofen.** (Elektrotechn. Zeitschr. 22. pp. 635–637, Aug. 8, 1901. Paper read before the Verband Deutscher Elektrotechn. at Dresden.)—The author gives an illustrated description of the poles, brackets, couplings, &c., used by the Allgemeine Elektricitätsgesellschaft, suitable for either copper or aluminium overhead distributing systems working at a pressure below 1,000 volts. A. H.

2056. *Motors for Electric Automobiles.* **P. Gasnier.** (Ind. Élect. 10. pp. 342–347, Aug. 10, 1901.)—This article contains particulars of a considerable number of motors of various sizes and types, manufactured by the Postel-Vinay Company, and including, in some instances, details of the running gear with which they have been employed. Figures and curves are given relating to their outputs, weights, speeds, efficiencies, &c., and some illustrations of their mechanical design. E. J. W.

2057. *Farnworth Electricity Works.* (Elect. Engin. 28. pp. 258–266, Aug. 23, 1901.)—A description with drawings of the lighting and tramway system in this town. Three Lancashire boilers, 30 ft. by 7 ft. 6 in., and three 120-kw. continuous-current generators have been installed. There is also a battery, giving 20 kw. for 10 hours. W. H. S.

2058. *Electricity Works in Germany.* (Elektrotechn. Zeitschr. 22. pp. 720–742, Sept. 5, 1901.)—A list in tabular form of the various electric light stations in Germany, giving particulars about each. [See also Abstract No. 2357 (1900).]

TELEGRAPHY AND TELEPHONY.

2059. *Rowland's Multiplex Printing Telegraph.* **G. Robichon.** (Journ. Télégraph. 25. pp. 6-9, Jan.; 25-28, Feb.; 73-76, April; and pp. 175-179, June, 1901.)—This was briefly alluded to in Abstract No. 1309 (1899). Four messages can be sent each way. Alternate currents are employed and the generator and motor at either end of the line are in synchronism. The signals are made up by suppressing at the station of origin one or more half wave-lengths of current which cause the armatures of selective relays to close local contacts for certain periods of time, and thus actuate the printing type letters. These armatures are oscillating until the sudden suppression of current leaves them on one contact or the other. The period of a complete wave intervenes between these suppressions; otherwise the contact would be of the same sense in both cases, which is not desired. The sector or distributor has eleven studs, and a revolving arm, geared to the transmitting alternator, comes successively into contact with these studs. Such a contact, through the medium of the keyboard and a local electromagnet, momentarily cuts off the line, and suppresses a half-period. Contact with all the studs, one after the other, were the local circuit complete, would mean the suppression of eleven half-periods. But the arrangement of the keyboard is such that, for each letter depressed, two half-periods, non-successive, are cut off. The transmitter is lettered and the keys arranged similarly to a typewriter. When a key is pressed it raises two levers which come into circuit with two separate studs of the distributor, a local battery, an electromagnet, and the contact arm above mentioned, which revolves round the distributor. When this local circuit is complete the armature of the electromagnet moves and interrupts the line, thus cutting off a half-period of current. Were the time of contact or manipulation of the key to be solely at the judgment of the operator, the performance would be liable to irregularity. Hence there is an arrangement, worked electromagnetically, by which one key only can function during any one revolution of the arm of the distributor, the end of the lever of such key being kept hooked up, and in continuous contact with the sector during the whole of that one revolution. The operator is made sensible by touch of the working contact having been properly made. A counter, worked by a click, indicates to the sending operator when the time has come to alter the position of the paper hand under the type-wheel, and to use the appropriate key: to this is added a bell which rings when the end of a line is near.

Synchronism is effected by the second oscillating armature of the line relay as follows. Its tongue plays between the + and — poles of a battery. These poles are connected also to two condensers respectively; these condensers being in parallel, their middle point is joined to auxiliary bobbins of a small motor which is separately driven, and causes the arm of the distributor to turn round; the other terminal of the bobbins is joined through a telephone to the body of the oscillating tongue. The small motor thus receives + and — pulsations as long as the tongue moves in sympathy with the alternations of the line current, and the suppression of half-waves does not disturb its movement. This arrangement has for its object to cause a certain note to be emitted by the telephone which shall indicate that synchronism is being maintained, and also to exercise a very slight acceleration or retardation upon the working armature in case of deviation from synchronism. When such takes place, the current working the motor can, by means of a rheostat, be adjusted and synchronism restored.

When, however, a line circuit is introduced, absolute identity of movement is unfavourable. There is a slight retardation in transmission which must be taken account of. One distributor must be "oriented" with regard to the other. This is effected by a special relay and by the peculiar mounting of the arm of the receiving distributor. The axis of that arm is commanded by the synchronising motor, but the arm is not rigidly secured to the axis; it turns with it by slight friction. Alongside of the arm and rigidly fixed to the axis is a disc of metal which has a certain number of indentations equidistant, the space separating two consecutive ones being equal to two divisions of the crown of the distributor. The arm carries an electromagnet whose armature prolonged forms a click or little tongue which in repose engages in one of the holes or indentations of the metal disc and serves to unite the arm with the disc, and normally the two revolve together. The electromagnet is in the local circuit of the relay of "orientation," which is itself connected to one of the contacts of the distributor. At the transmitting station a wave of current is suppressed when the arm rubs on a similar contact. If, at the receiving end, the arm is simultaneously passing over the relay contact, matters are so arranged that the relay does not function, the little tongue or click remains locked with the disc, and the regular movement of the arm and disc is uninterrupted. Otherwise, however, the local circuit is momentarily closed, the little tongue or click is drawn back, the arm falls behind the disc by the space of two divisions, and the tongue again locks. In the succeeding and following revolutions, if the correct relation has not been established, the same thing occurs until the object is effected. To indicate to the sending stations that concordance has been secured there exists a second contact on the distributors through which a second wave is automatically suppressed at each revolution. A special relay acts at the sending station by means of these contacts to ring a bell when the relation between the movements of the arms at the sending and receiving ends are in proper relation.

E. O. W.

2060. *Duplexing of Cables.* **H. H. Kingsford.** (Inst. Elect. Engin., Journ. 30. pp. 1020–1021, June, 1901.)—By placing a resistance earthed at about its middle point between the commencement of the cable and that of the artificial line, the latter can be much reduced both in capacity and resistance, without making any perceptible difference to the duplex balance, the signals at the distant end being as easy to read as they were before the earthed shunt was applied. The author first employed this method to obviate the embarrassment arising from a fall in insulation of underground cable between hut and office. In one case quoted, a leak resistance, equal to that of the fault, is also applied at the beginning of the artificial line. E. O. W.

2061. *Type-printing Telegraphy.* **W. B. Vansize.** (Amer. Inst. Elect. Engin., Trans. 18. pp. 349–362, May, 1901.) (Discussion.)—This is the report of the discussion on the paper referred to in Abstract No. 1018 (1901). Further details of the construction of the apparatus are given, and incidentally some useful particulars are stated by **F. W. Jones** and others when comparing the speeds to be attained by various systems of sending and receiving. The best that Morse operators of the greatest skill can do in a

day's all-round work is 30 words per minute, using a sounder and an ordinary type-writing machine. In forming an estimate of the merits of any automatic system, attention must be directed to the expenditure of time at the start, and at the finish of a message, as well as to the expense of preparing tapes and translating them. The Wheatstone system was introduced into the United States in 1880; there were then seven circuits installed, but to-day there are only five. The rate of pay of operators and the number of messages they can transmit per day is also discussed. It is stated that for several years past the average length of a message (Boston-New York) is from 29 to 30 words. Each operator sends from 60 to 65 messages per day.
R. A.

2062. *Speed of Signalling by Simple Sine-wave Transmission.* **F. Breisig.** (Elektrotechn. Zeitschr. 22. pp. 415–419, May 16, 1901. Communicated by the Kaiserl. Telegraphen-Versuchsamt.)—This is a critical examination of the method adopted by Crehore and Squier for the transmission of signals through cables using current impulses of simple sine form. The question at issue is whether the signals transmitted by the alternate-current generator for practical cable work, consisting as they do of periodic half-waves, following one another in an irregular sequence of positive and negative impulses, can be regarded as mathematically equivalent to an alternate current of sine form. There follows the further question as to whether such signals can be transmitted at a speed greater than is possible with ordinary battery currents. To investigate the matter, the author considers the case of transmission of periodic impulses in which the time interval between any two successive contacts at the sending end is great enough to allow each impulse completely to vanish before it is followed by another. As minimum legibility is obtained with such recorder signals as are formed of a series of successive impulses all of the same polarity, the investigation is limited to a series all of one sign. Assuming that legibility is to be judged by comparison of amplitudes at equivalent potential differences, the author criticises the conclusions of Crehore and Squier. In their experiments comparing the speeds obtained respectively by battery currents and alternate currents, Crehore and Squier defined equivalent voltages as those having the same maximum values at the sending end of the cable. For alternate-current sending, the volts were directly measured; and the amplitudes were calculated by multiplying the effective volts by $\sqrt{2}$. The equivalent voltage in the case of a battery current was assumed to be simply the e.m.f. of the battery. This assumption is severely criticised by Breisig. He regards it as leading to false conclusions, and he expresses the opinion that sine-wave alternators have no advantage over batteries as regards speed of signalling through cables. [See further Abstracts Nos. 1014 (1901) and 1969 (1900).] R. A.

2063. *The Electrograph.* (Scientific American, 84. pp. 373–374, June 15, 1901.)—In this instrument the transmitter has a rotary cylinder round which is curled a zinc enlargement of a half-tone plate, the depressed portions corresponding with the etched portions of the original half-tone being filled with an insulating material. Upon the surface of this plate glides a stylus, which is caused to travel along the rotating cylinder by a carriage. Upon a piece of ordinary paper wrapped upon the cylinder of the receiving instrument plays an inked pen, which is caused to travel along the rotating receiver-cylinder, the inked pen being withdrawn from the paper when the stylus at the transmitting end is in contact with insulating material. The apparatus has worked over a line 770 miles long, and through 20,000 ohms of line resistance, and is the invention of H. R. Palmer, T. Mills, and W. P. Dun Lany. The paper is illustrated by some photographs. Further details are given in British patents Nos. 6159 and 6160 of 1899. C. K. F.

2064. *Wireless Telegraphy.* **F. Poncelet.** (Soc. Belge Élect., Bull. 18. pp. 200–221, May, 1901; also Elect. Engin. 28. July 12 and 19, 1901.)—A description of some experiments carried out by Guarini and the author between Brussels, Malines, and Antwerp, with Guarini's automatic repeater. The distances between successive stations are only about one-third of those obtained by Marconi. The paper also contains statements as to a method of obtaining a beam of electrical radiation from a vertical wire, but does not give any experimental results in confirmation. J. E.-M.

REFERENCES.

2065. *Dynamo in Recent Telephone Practice.* **D. M. Bliss.** (Elect. World and Engineer, 37. pp. 308–310, Feb. 23, 1901.)—The author describes types of dynamo and storage cells (their arrangement and care) best suited to central battery telephone systems. Illustration and diagrams are given. J. E. K.

2066. *Modern Telephone Engineering.* **K. B. Miller.** (Elect. World and Engineer, 37. pp. 712–714, May 4, and 765–768, May 11, 1901.)—A full description of the most modern arrangements in exchanges with central batteries and lamp signals in place of electromagnetic indicators, with diagrammatic illustrations of the connections and the modes of putting up strips of relays, lamps, and jacks. There are also diagrams of load curves showing the business of an exchange at different times and days. E. O. W.

2067. *Wireless Telegraphy.* **G. Marconi.** (Soc. Arts, Journ. 49. pp. 506–515; Discussion, pp. 516–517, May 17, 1901.)—This is an account of the author's experiments in the direction of obtaining syntonism in wireless telegraphy. A short review of the subject is given, and references to various patents concerning the form and disposition of apparatus. Examples of the practicability of syntonic wireless telegraphy are cited, and the suggestions of Slaby and others are criticised. [Syntony was discussed by O. Lodge, January 21, 1898, at the Physical Society, see Proceed. Phys. Soc. Lond., vol. xvi. pp. 58–61, 1898.] R. A.

2068. *Transmitters for Wireless Telegraphy.* **F. Braun.** (Elektrotechn. Zeitschr. 22. pp. 469–470, June 6, 1901.)—In continuation of his paper [Abstract No. 1464 (1901)] on modifications in the Marconi system of wireless telegraphy, the author describes a number of methods of inductive and other excitations of the transmitter. The connections include the use of inductive coils and condensers in connection with spark-gaps. G. H. B.

2069. *Wireless Telegraphy.* **R. A. Fessenden.** (Elect. World and Engineer, 37. pp. 1103–1104, June 29, 1901.)—The American Weather Bureau has instituted experiments on syntonic wireless telegraphy, somewhat on the same lines as those of Marconi. They are here referred to in general terms, but awaiting the granting of patents, no details are given. R. A.